1976

Mammals of the Bull Run

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AN ABSTRACT OF THE THESIS OF Edward M. Thatcher for the Master of Science in Biology presented 20 September 1976.

Title: Mammals of the Bull Run

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This study of mammals of the Bull Run Planning Unit has a dual character. First, mammals of special scientific or natural history interest such as threatened or endangered species were sought. This was in conjunction with a Mt. Hood Bull Run Planning Unit. Second, a zoogeographical study of mammals of the Bull Run was performed. Abundance and distributional data was recorded for each species observed. This data was related to availability of moisture as indicated by plant associations trapped. Difference in

habitat utilization along a moisture gradient was investigated as a possible coexistence mechanism for sympatric small mammals in the Bull Run Planning Unit.

MAMMALS OF THE BULL RUN

by

Edward M. Thatcher

A thesis submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE
in
BIOLOGY

Portland State University
1976

TO THE OFFICE OF GRADUATE STUDIES AND RESEARCH:

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ACKNOWLEDGEMENT

I would like to extend my appreciation and sincere thanks to the following people for their assistance and encouragement; my committee members, Dr. Richard B. Forbes, chairman, Dr. Robert O. Tinnin, Dr. John H. Wirtz, and Dr. Cord Sengstake; and Mr. Kirk Horn and Miss Nancy Meador of the Mt. Hood National Forest.

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INTRODUCTION

The 142,080 acre Bull Run Reserve, located in the western Cascades about 30 miles east of Portland, Oregon, was set aside in 1892 by President Benjamin Harrison as the source of water for the city of Portland. The Reserve was given further legal protection by the Trespass Act of 1904, and by a 1909 Act of Congress to prevent trespass and protect the forest.

The production of high quality water was the main use of the Bull Run Reserve until 1958 when the Mt. Hood National Forest began managing large-scale commercial logging operations within the Reserve. The logging has been performed since then on a one-hundred year rotation or cycle in which one percent of the harvestable timber is removed from the Reserve each year. In conjunction with logging activity and fire control, approximately 300 miles of roads have been constructed in the Bull Run Reserve.[1] A recent opinion by United States District Court Judge James M. Burns states that logging operations in the Bull Run Reserve are contradictory to the protection of the forest for production of high quality water.

In 1969 Congress passed the National Environmental Policy Act which necessitates the formulation of an Environmental Impact Statement before human activities

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[1] Portland City Club Bulletin, 1973. Report on Management of Forest Resources in the Bull Run Division.

potentially detrimental to the environment can be undertaken on Federal lands. In addition to the necessity of an Environmental Impact Statement, Forest Service activities on public lands of the Mt. Hood National Forest have recently been admininstered according to land use planning techniques that attempt to determine suitability of such human activities as clear-cut logging and hydroelectric dam constru tion for an area. In response to the needs for and E.I.S. and the advent of land use planning, the Mt. Hood National Forest began a multi-disciplinary land use planning study of the Bull Run Planning Unit in 1973.[2] The study included hydrology, geology, botany, geography, vertebrate zoology, timber management, and an investigation of the mammals of the Planning Unit. The objectives of my study were to ascertain whether any threatened mammalian species occur within the Bull Run Planning Unit, and a zoogeographical survey of the mammals there. Occurrence of threatened and endangered mammals within the Bull Run Planning Unit is of importance to the determination of suitable land use owing to the possibility of extirpation of species through further degradation of habitat. Clear cut logging, for example, involves the total destruction of virgin forest habitat which could affect populations of some threatened

[2] Parts of the Bull Run Reserve are included in the Bull Run, Larch Mountain, Eagle Creek, Mt. Hood, and Lava Planning Units.

mammals. For example the fisher (*Martes pennanti*)

> ..lives largely within the Canadian and Upper Transition life zones in heavy timber; since many timber areas have been cut, it seems likely that the fishers range is becoming seriously limited (Ingles, 1965).

Ingram (1973) states

> Logging and burning of forests in Michigan and Minnesota in the early 1900's had an adverse effect on the fisher population. Logging and fires were also factors in the decline of the fisher in New York. Scarcity of fishers in Minnesota was related to over-trapping and logging practices.

The Bull Run Planning Unit provides a vast array of natural old growth coniferous forest habitat, and forest of varying age regenerating after clear-cut logging. I emphasized study of the distribution of mammals in old growth forest.

MATERIALS AND METHODS

This study was initiated in June 1973 and extended through the middle of October 1973 when field work was ended because of heavy rains and imminent snows. During this period, I identified 28 mammal species. One hundred eighty-three small mammals were captured in snap traps and 102 observations of large mammals were recorded (Appendix A).

Records were kept on mammals captured within a given habitat type in order to study relative habitat specificity and preference of each species. Small mammals were captured in Museum Special snap traps in sites containing 108 traps per site. Trap sites were organized into 6 trap lines spaced approximately 10 yards apart with 18 trap stations (1 trap/station) per line spaced approximately 5 yards apart. In old growth forest, often large diameter trees, rocks, snags, streams, *etc.*, precluded placing snap traps in exact positions.

Each of sixteen trap sites was maintained for 7 consective nights through the course of the study. Traps were baited with peanut butter and rolled oats. Trap success was recorded as number of individuals of each species captured per evening. Study skins and skulls were prepared for confirmation of identifications. Eighty-nine small mammal specimens were prepared; 34 were subsequently deposited in the Portland State University collection of vertebrates. Binomial and trinomial nomenclature were

largely taken from Jones *et al.* (1975) and Ingles (1965).

Trap site location and elevation were recorded from Forest Service topographic maps, slope angle was determined by clinometer readings, and aspect of the slope was read from a compass. The trap sites were characterized according to presence or absence of plant species. Plants were classified as canopy, small trees, seedlings, shrub, or herb species (Appendix B). Plant associations defined by Franklin and Dyrness (1973) were used as indicators of abiotic factors especially the availability of moisture. It was possible to define a habitat gradient along the lines of availability of moisture from moist to dry sites in the Bull Run Planning Unit (Figure 3). Hence, different positions along a moisture gradient at low (*Tsuga heterophylla* zone) and high elevations (*Abies amabilis* zone, Franklin, 1973) as determined by plant associations as indicators, were trapped in order to determine the response of small mammal species to this gradient.

Large mammals were observed and identified in a variety of ways. National live traps were set for such rodents as *Tamiasciurus douglassi, Neotoma cinerea,* and *Aplodontia rufa.* Live traps approximately 1-1/2 ft. by 3 ft. were set for such mammals as *Mustela vison, Procyon lotor,* and *Vulpes fulva.* Observation and identification, when possible, were made by analyzing tracks and scats. Calls, such as those of *Tamiasciurus douglassi* and *Ochotona*

princeps, could be identified, and visual identification was often possible. Bats flying over Bull Run Lake were hunted with .410 shotgun. Records of tracks, scats, sounds, sightings, road kills, and notes from informants were recorded.

DESCRIPTION OF STUDY AREA

The Bull Run Reserve includes the Bull Run watershed (approximately 67,000 acres), a buffer zone, parts of the Eagle Creek Roadless Area, Old Maid Flats, Zig Zag Mountain, and Lolo Pass. The last three areas are now open to the public. The land within the Bull Run Reserve still closed is referred to as the Bull Run Division (100,000 acres). The Bull Run Reserve is characterized by high relief. Elevations range from 750 ft. near the Headworks (the point at which water enters the conduits leading to Portland and chloramination occurs) to 4,600 ft. at Hiyu Mountain. Major topagraphic features include other mountains such as Preachers Peak, Sentinel Peak, Big Bend Mountain, Blazed Alder Butte, Hickman Butte, and Burnt Peak all of which are over 4,000 ft. in elevation. The physical watershed is composed of a series of small streams and rivers that eventually flow into the Bull Run River. Two large dams form reservoirs numbers 1 and 2, which in addition to Bull Run Lake and the North Fork Reservoir, provide the major water storage capacity within the drainage.

The Bull Run Watershed shows evidence of Pleistocene glaciation in the form of small U-shaped valleys including Bull Run Lake, Blue Lake, and Hickman Creek, and cirque glaciers such as Hickman Lake and the northwest aspect of Hiyu Mountain.

The Reserve includes three major geologic units. The

underlying bedrock is approximately 600 ft. of Columbia River Basalt deposited in the middle Miocene. The Rhododendron Formation, approximately 500 ft. of volcanic breccias and flows of platy andesite, overlies the basalt and was deposited roughly 7 million years ago. Pliocene volcanic activity in the Bull Run region produced the next major geologic unit, the Cascade Andesite Formation. These andesite flows were deposited over Rhododendron Formation approximately 2-7 million years ago (Beaulieu, 1974).

Figures 1 and 2 present two graphical interpretations of climatic conditions in the Bull Run Reserve at different elevations. From these graphs, it can be seen that precipitation falls mainly in the winter months with increasing amounts at higher elevations. Temperature maxima are in the summer months (data obtained from the U. S. Weather Bureau reports for 1973).

The high relief in the Bull Run Reserve plus winter precipitation result in lush growths of vegetation that change radically with elevation and availability of moisture. Two of Merriam's life zones, as defined by Bailey (1936), occur within the Planning Unit. The Humid Transition occupies elevations up to approximately 3,000 ft. on northeast slopes and 4,000 ft. on southwest slopes. The higher elevations are included within the Canadian life zones. These two life zones correlate well in elevational ranges with the two climax zones found in the Planning Unit.

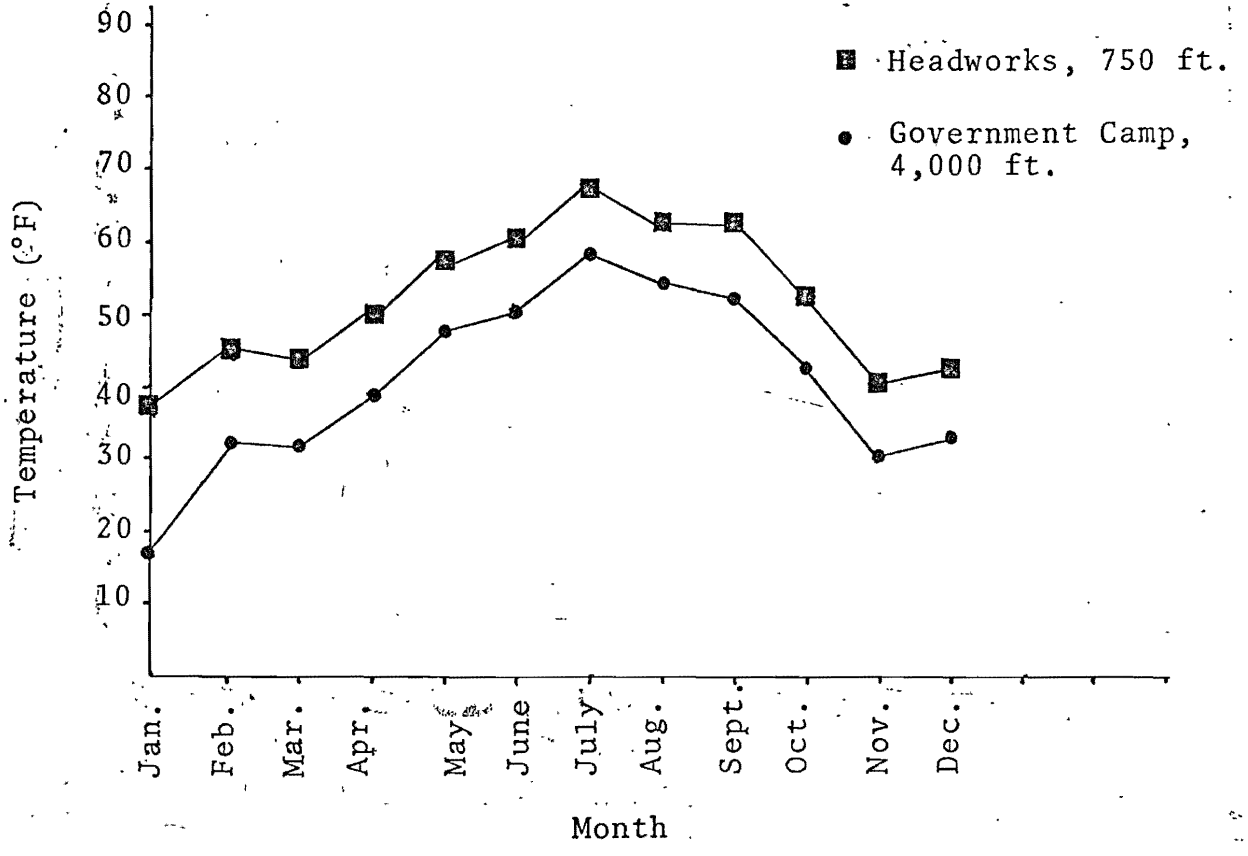


Figure 1. Average monthly temperature for 2 stations in 1973.

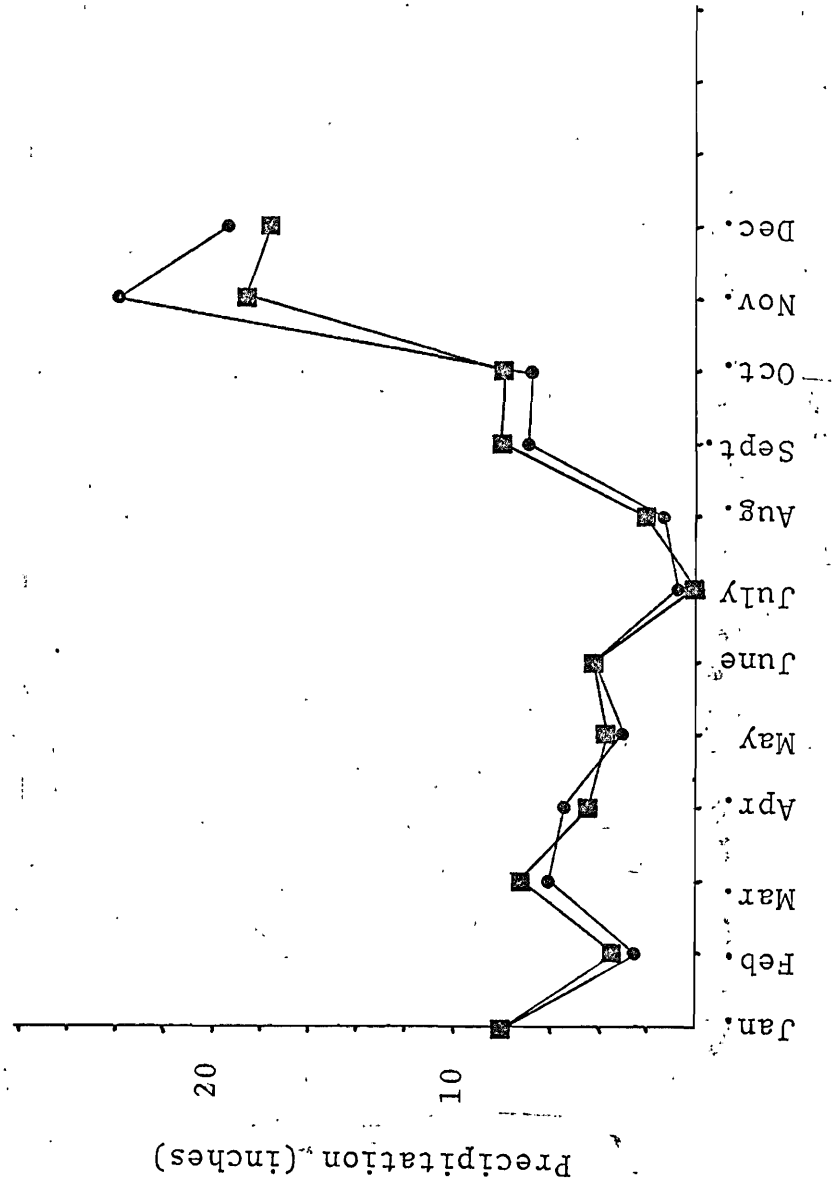


Figure 2. Average monthly precipitation for 2 stations in 1973.

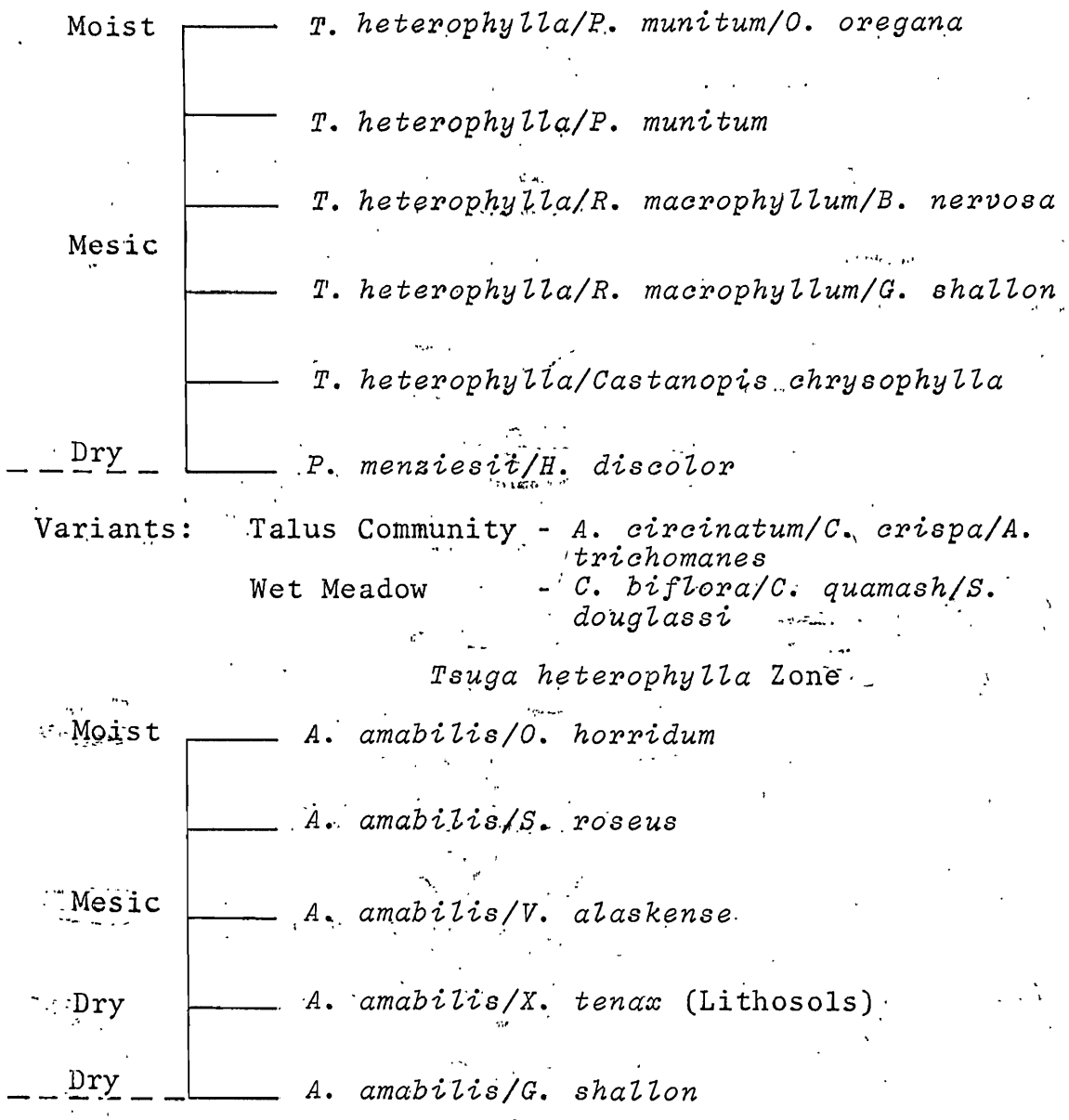


Figure 3. Plant associations along moisture gradients in 2 climax zones (Franklin, 1973).

The Humid Transition correlates well with the *Tsuga heterophylla* zone, and the Canadian with the *Abies amabilis* zone (Franklin, 1973). The range in elevation and soil characteristics, plus varying slope angles and aspect result in many moisture regimes and gradients.

According to Franklin and Dyrness (1973) "moisture stresses are sufficient to result in distinctive community spectra along moisture gradients." Hence, it is possible to define distinctive communities within the Bull Run Planning Unit that correspond to position on a moisture gradient. Two line graphs which indicate typical plant associations characteristic of dry to moist sites in both the *Tsuga heterophylla* and *Abies amabilis* zones are shown in Figure 3.

SPECIES ACCOUNTS

Order Insectivora

Family Soricidae

Sorex vagrans (vagrant shrew)

S. vagrans is widely distributed throughout western, northeastern, and eastern Oregon; most of central Oregon is uninhabited by this species (Ingles, 1965; Hall and Kelson, 1959). *S. vagrans* is found in moist, forested habitats of the Humid Transition and Canadian life zones (Bailey, 1936). It is generally agreed that the vagrant shrew consumes insect eggs, larvae, and adults, and other invertebrates; occasionally small mammal remains are found in its stomach contents (Larrison, 1976; Bailey, 1936; Ingles, 1965). *S. vagrans* was easily identified in the field by its brown, summer pelage and an indistinctly bicolored tail (Ingles, 1965).

Nineteen vagrant shrews were trapped between 2,000 ft. in the *Tsuga heterophylla* climax zone and 4,000 ft. in the *Abies amabilis* zone (Franklin and Dyrness, 1973). This range in elevation includes both the Humid Transition (3,000 ft. to 4,000 ft. upper limits on cool northeast and warm southwest slopes respectively) and the Canadian life zones (3,000 ft. to 4,000 ft. lower limits in elevation, Bailey, 1936). *S. vagrans* was captured in 56.3 percent of all trap sites throughout the study area.

S. vagrans seemed to prefer moist habitats within the

coniferous forests of the Bull Run Planning Unit. This trend seems especially evident in the *A. amabilis* zone (Figure 4). *S. vagrans* was not trapped in dry talus communities, but one specimen was collected in a wet meadow at low elevation.

Sorex palustris (water shrew)

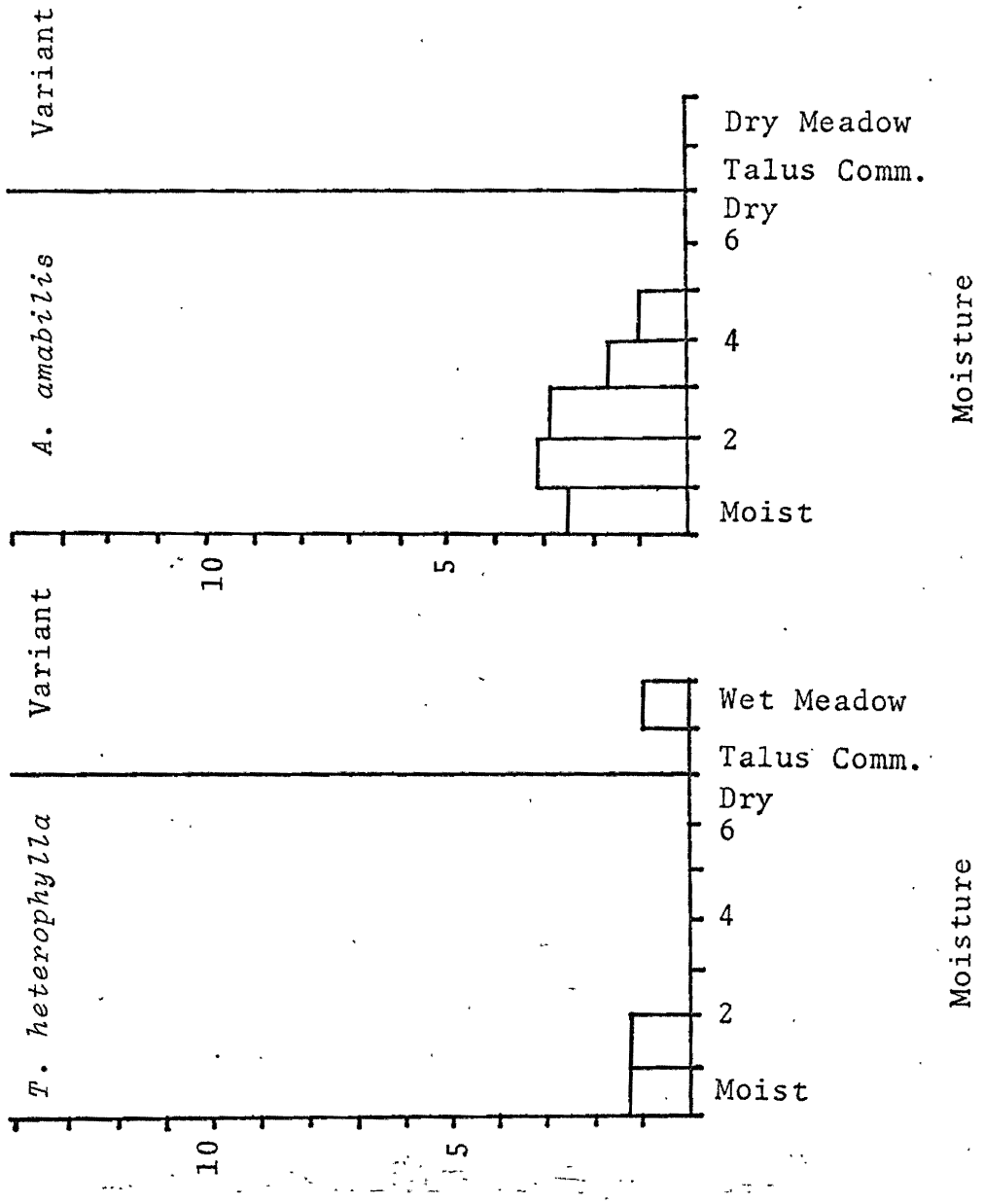
S. palustris is found in the Canadian and Hudsonian life zones of the Cascade Mountains and northeastern mountains in Oregon (Ingles, 1965; Hall and Kelson, 1959). This shrew occurs near high mountain lakes and rushing streams. The water shrew is identified by a white-frosted ventral pelage, a distinctly bicolored tail, and fimbriated feet.

Two *S. palustris* were captured beside a small, fast-moving stream flowing into the SE corner of Bull Run Lake at 3,175 ft. in the Canadian life zone.

Sorex trowbridgii (Trowbridge's shrew)

S. trowbridgii is limited mainly to the western third of Oregon in the Humid Transition life zone (Ingles, 1965; Hall and Kelson, 1959). Food habits are very similar to those listed for *S. vagrans*. Indentification of this species was mainly based on its sooty to dark gray pelage and distinctly bicolored tail.

S. trowbridgii was collected in 68.8% of all trap sites from 2,000 ft. in the *Tsuga heterophylla* zone to 4,000 ft. in the *Abies amabilis* zone. Ingles (1965) and



Abundance/# of sites of a given plant association trapped.

Figure 4. Distribution of *Sorex vagrans*.

Larrison (1976) describe *S. trowbridgii* as occurring in the Humid Transition zone of western Oregon. However, I collected *S. trowbridgii* in the Canadian life zone also. Trapping success was much higher at low elevations (Figure 5), yet Trowbridge's shrew was obtained in all high elevation plant communities except dry meadows. *S. trowbridgii* seems to occupy a much broader range of habitats than *S. vagrans* along moisture gradients at both high and low elevations. *S. trowbridgii*, unlike *S. vagrans*, was trapped in talus communities but not in wet meadows.

Family Talpidae

Neurotrichus gibbsii (shrew-mole)

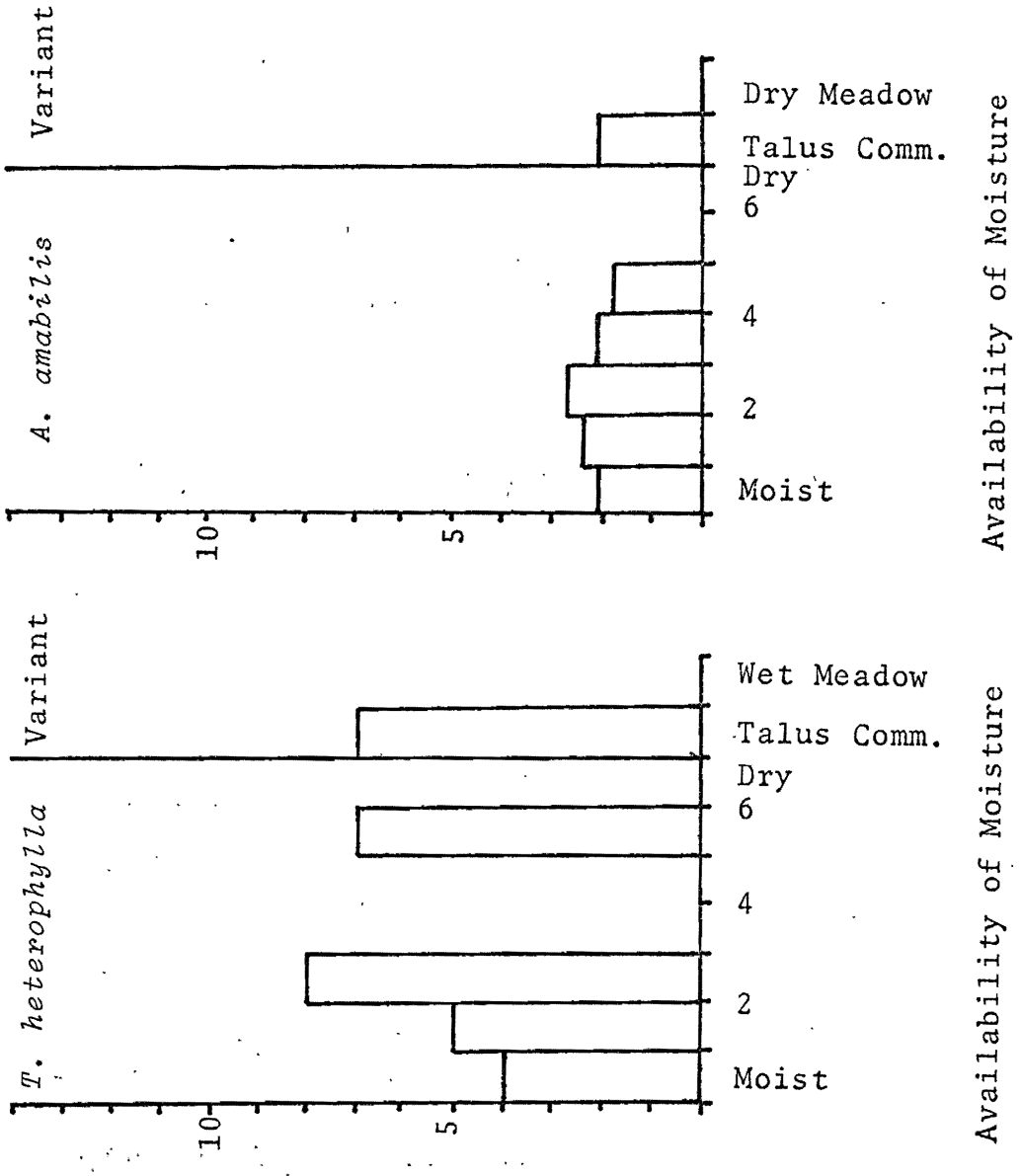
N. gibbsii occurs in moist habitats of the coniferous forest from the coast to the western Cascades in Oregon (Ingles, 1965; Hall and Kelson, 1959). The shrew-mole feeds mainly on small invertebrates such as insects, annelids, and isopods; some plant materials are also consumed (Larrison, 1976). The shrew-mole, identified by its short, scaly tail, was collected at low elevation (2,000 ft.) in very moist habitats (Figure 6).

Order Chiroptera

Family Vespertilionidae

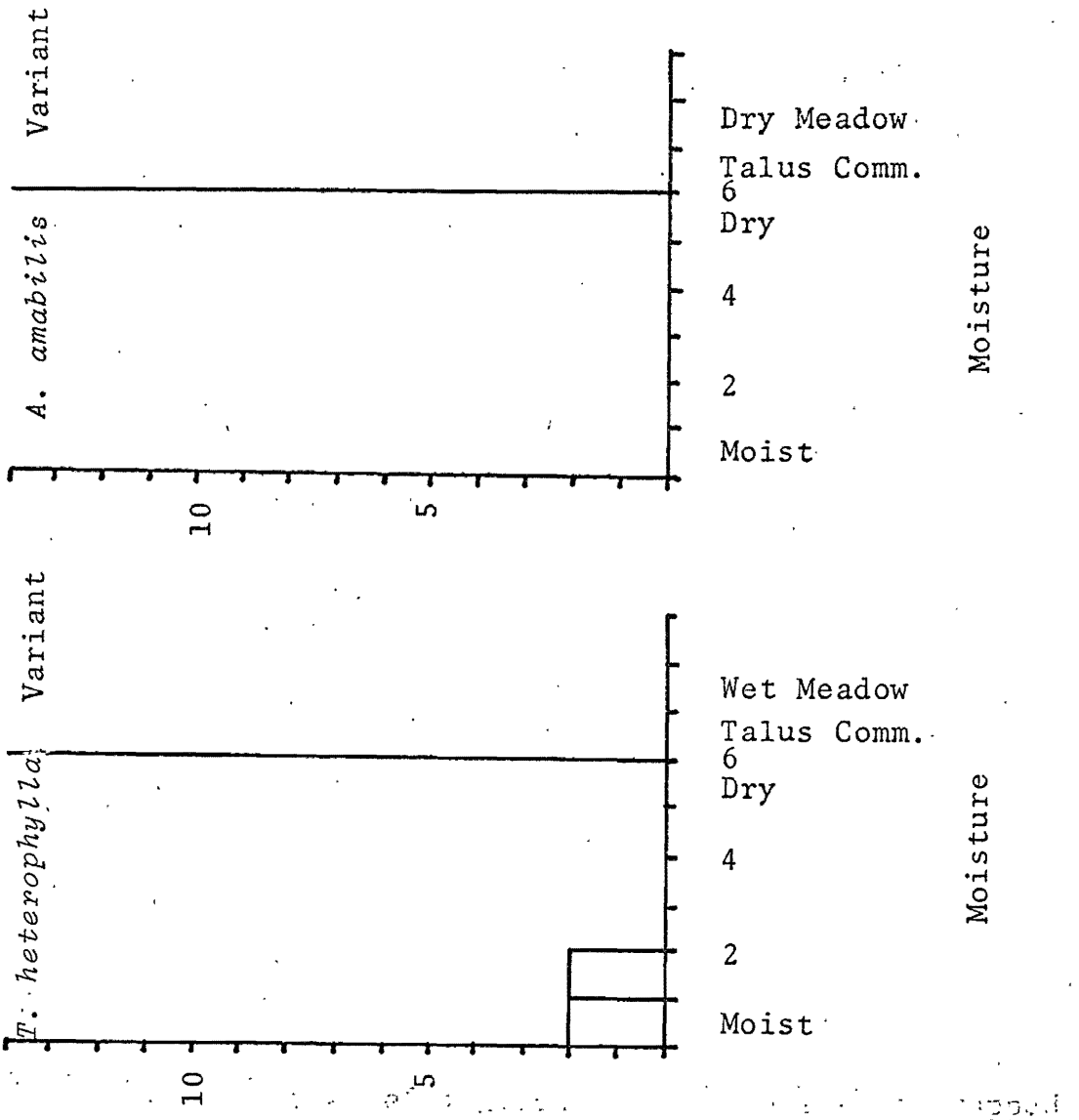
Myotis californicus (California myotis)

M. californicus occurs throughout Oregon in all life



Abundance/# of sites of a given plant association trapped.

Figure 5. Distribution of *Sorex trowbridgii.*



Abundance/# of sites of a given plant association trapped.

Figure 6. Distribution of *Neurotrichus gibbsii*.

zones except the highest in elevation (Ingles, 1965; Hall and Kelson, 1959). The California myotis is solitary during the summer (Bailey, 1936), and emerges to hunt over lakes and ponds during the early evening. I collected two specimens from the NW corner of Bull Run Lake at dusk with a .410 shotgun. This small bat was identified by the presence of a keeled calcar. Insects taken during flight appear to be the main food resource of this species (Bailey, 1936).

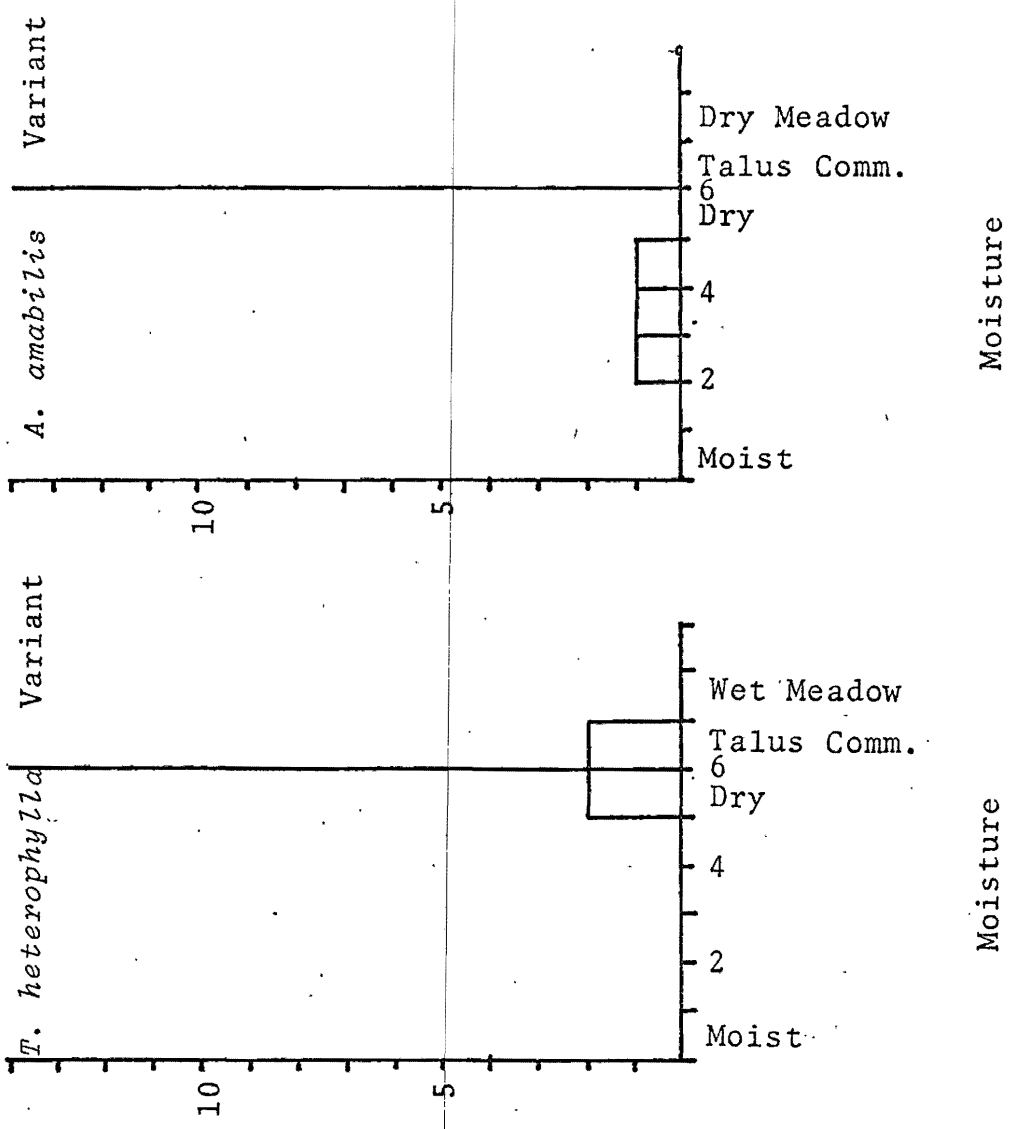
Order Lagomorpha

Family Ochotonidae

Ochotona princeps (pika)

O. princeps is found in talus slopes and rock outcrops in the Cascade Mountains, southcentral, and northeastern Oregon (Ingles, 1965; Hall and Kelson, 1959). The pika is noted for storing grasses and other herbs in haystacks to dry. Its presence can be determined from this fact (Kawamachi, 1976). The pika generally occurs at higher elevations in the Canadian and Hudsonian life zones (Ingles, 1965).

The pika was identified many times, mainly by sound identification during the course of this study. The animal was recorded between 2,800 ft. in the *Tsuga heterophylla* zone and 4,300 ft. in the *Abies amabilis* zone. All sightings except one were made in talus fields (Figure 7)



Abundance/# of sites of a given plant association trapped.

Figure 7. Distribution of *Ochotona princeps*.

indicating habitat specificity to talus communities. One individual was trapped in the coniferous forest on the southwest side of Bull Run Lake in an area of lithosol soils with talus slopes within 200 meters (Figure 8).

Family Leporidae

Lepus americanus (snowshoe hare)

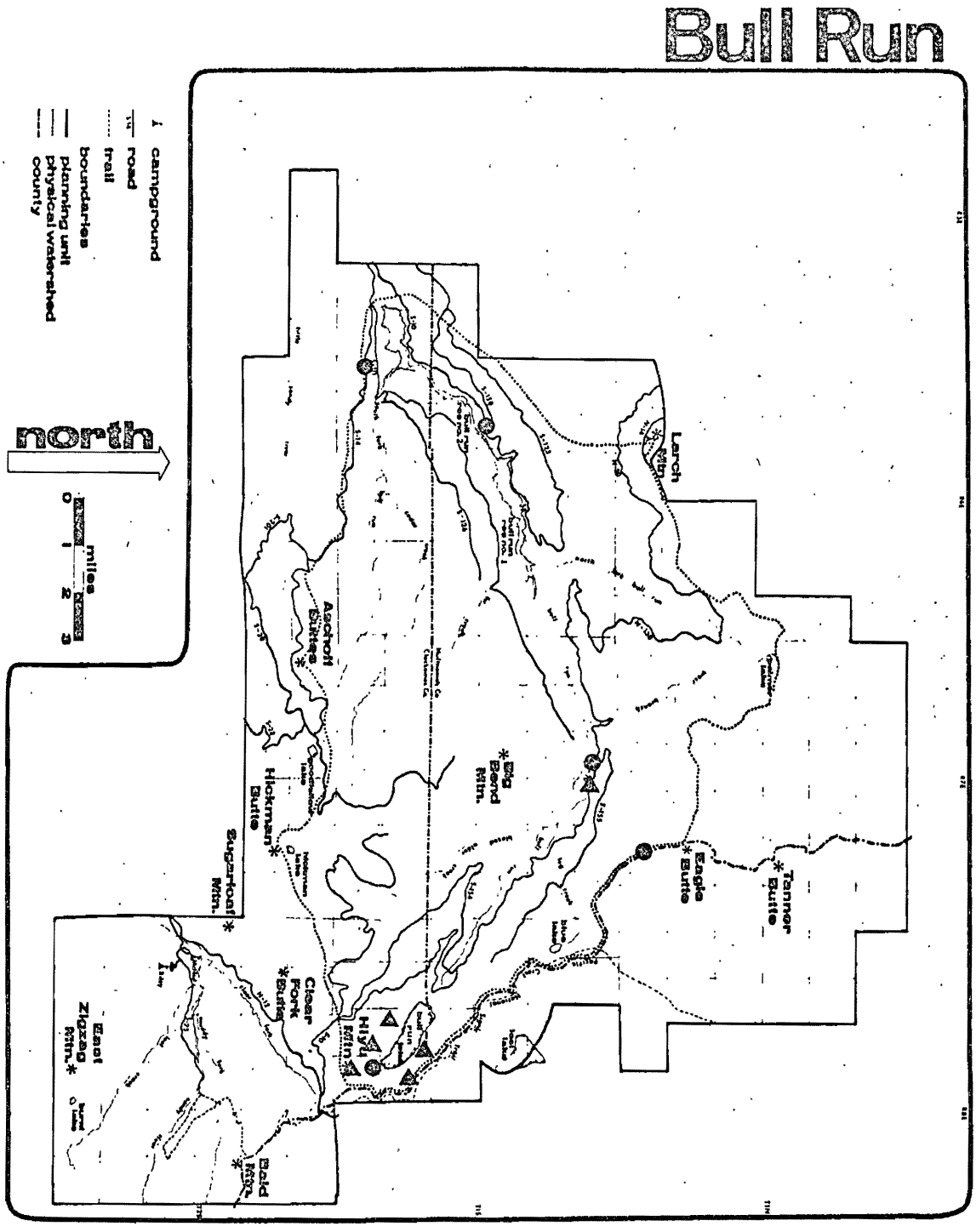
L. americanus is found in the Humid Transition and Canadian life zones in the western third of Oregon and the northeastern mountains (Ingles, 1965; Hall and Kelson, 1959). It occurs in the coniferous forest, eating twigs and bark of available deciduous and conifer trees, and grasses and forbs during the summer months (Ingles, 1965). Six individuals were seen at different times in the Bull Run Planning Unit between approximately 1,000 ft. and 3,500 ft. Identification was based on habitat, the animal's dark ear tips, and on its winter pelage during late fall of 1973 (Figure 8).

Order Rodentia

Family Sciuridae

Eutamias townsendii (Townsend's chipmunk)

E. townsendii occupies coniferous forest in western Oregon from the Cascade Mountains to the coast (Ingles, 1965; Hall and Kelson, 1959). This chipmunk eats mainly plant foods such as seeds, leaves, fruits, and some animal



Maps courtesy of the Mt. Hood National Forest.

Figure 8. Location of pika (▲) and snow-shoe hare (●) found in 1973.

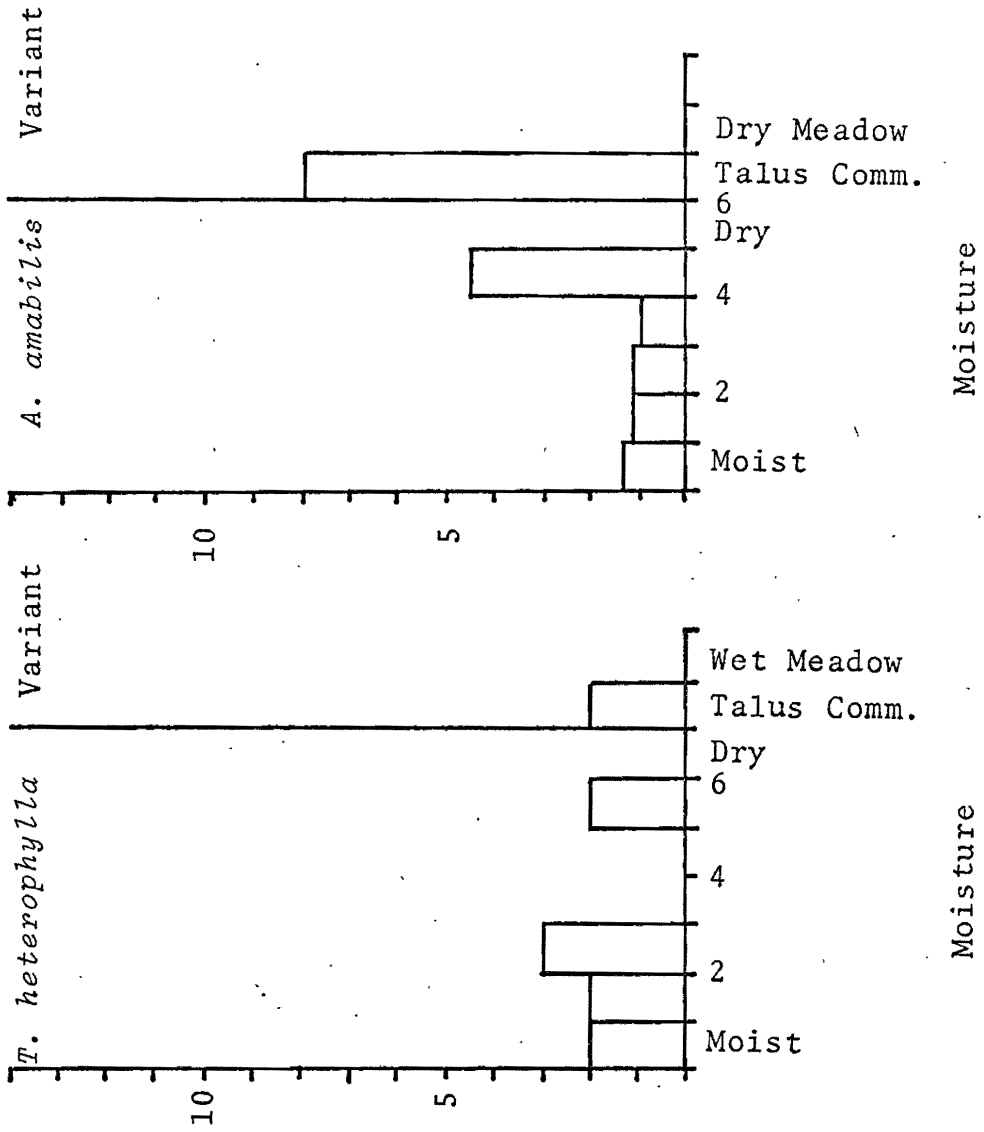
materials such as insects (Larrison, 1976). The animal occurs mainly in the Humid Transition almost exclusively in the forests (Ingles, 1965).

E. townsendii was captured in 56.3% of all trap sites with 20 specimens captured. The chipmunk was observed at 4,400 ft. on Preachers Peak in a dry meadow with much open ground and clumps of small, wind flagged subalpine conifers (Figure 9) to 2,000 ft. in the *Tsuga heterophylla* zone. The histogram for this species (Figure 9) indicates a broad range of plant associations and moisture regimes occupied. Only the wet meadow community at Deer Meadows failed to produce a captured individual or sighting. All other habitats showed evidence of the Townsend's chipmunk. The best trapping success was in a high elevation talus community.

Spermophilus beecheyi (California ground squirrel)

S. beecheyi occurs from near the Deschutes River westward to the coast in Oregon occupying most life zones except the Hudsonian (Ingles, 1965; Hall and Kelson, 1959). This rodent occurs mainly in grasslands, oak forests, and rock outcrops. Green vegetation is the preferred food, though animal materials are consumed (Larrison, 1976). This species was easily identified by its variegated coat and the black patch between the shoulders.

Only three individuals were observed during this study. All three individuals were seen as I drove along



Abundance/# of sites of a given plant association trapped.

Figure 9. Distribution of *Eutamias townsendii*.

roads in the Bull Run Planning Unit. The squirrels were generally scared by the approaching car into grasses lining the road, or in one instance, a clear-cut adjacent to the road. They were all seen in the Humid Transition in areas disturbed by the activities of man.

Spermophilus lateralis (Golden-mantled ground squirrel)

S. lateralis occurs throughout Oregon east of the foothills of the Western Cascades, in the Humid Transition and Canadian life zones especially Yellow-pine forests east of the Cascade crest (Ingles, 1965; Hall and Kelson, 1959). This squirrel is omnivorous, consuming seeds, berries, nuts, roots, plus animal materials. One golden-mantled ground squirrel was sighted at 3,500 ft. in a regenerating cleared area in the Bull Run Planning Unit. Two were live trapped at the cabins on Bull Run Lake. This species was only observed in the Canadian life zone, and was easily identified by golden shoulders and lack of striping on the head.

Tamiasciurus douglassi (Douglas squirrel)

T. douglassi is found in the Humid Transition through Hudsonian life zones of western Oregon (Ingles, 1965; Hall and Kelson, 1959). The Douglas squirrel occupies coniferous forest habitats. Conifer seeds are the staple of its diet, and are stored in caches. If seeds are not available, fungi are eaten by this arboreal squirrel (Larrison, 1976). *T. douglassi* was recorded between from 2,000 ft. at Cedar

Creek to approximately 3,500 ft. in the Bull Run Research Natural Area. This species was easily identified by its distinctive call, habits, and light venter (Ingles, 1965). The Douglas' squirrel is widely distributed in the forested regions of the Bull Run Planning Unit (Figure 11).

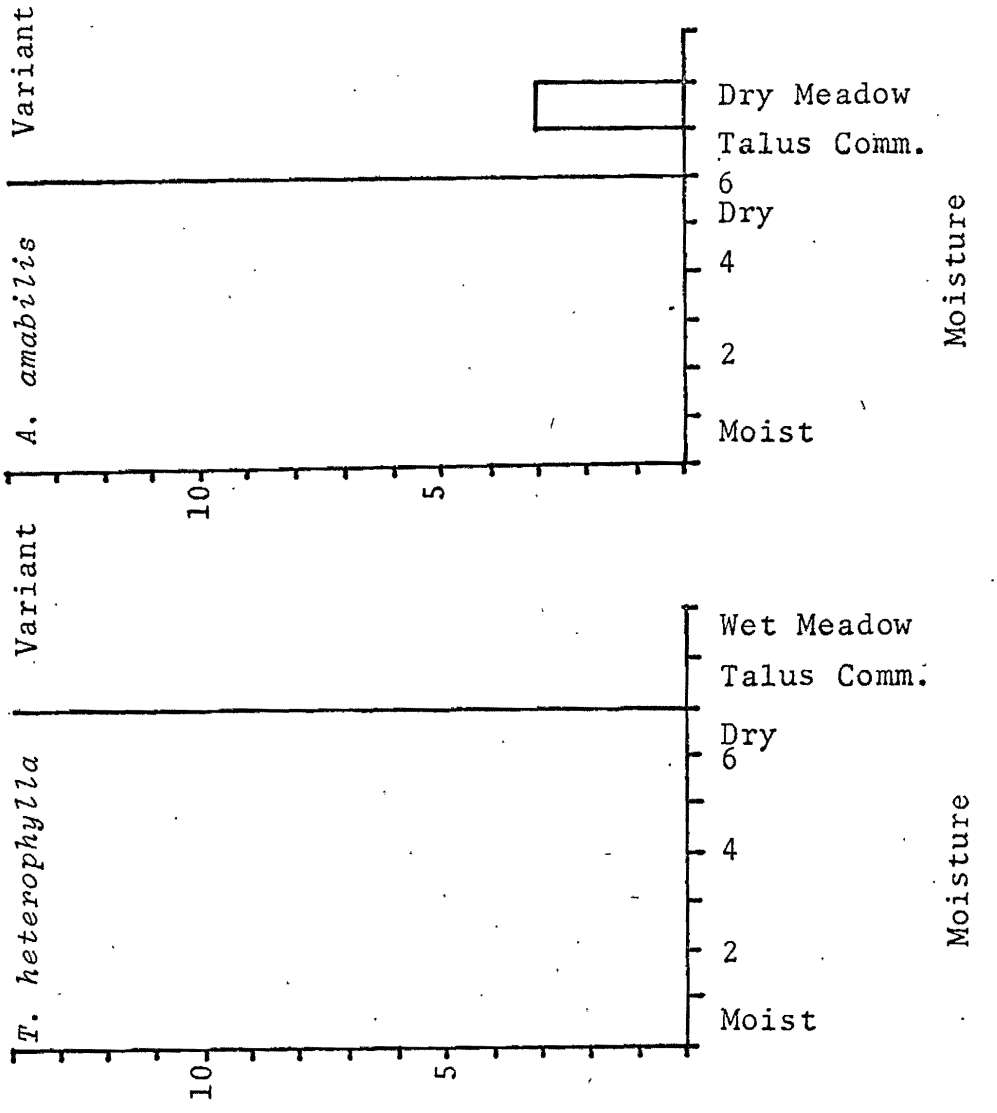
Glaucomys sabrinus (Northern flying squirrel)

G. sabrinus occupies the Humid Transition and Canadian life zones in coniferous forests of western and northeastern Oregon (Ingles, 1965; Hall and Kelson, 1959). The Northern flying squirrel dens in holes in trees, and consumes seeds, nuts, fungi, insects, and birds' eggs (Larrison, 1976). One road-killed specimen was found in the Bull Run Planning Unit south of Reservoir number 1.

Family Geomyidae

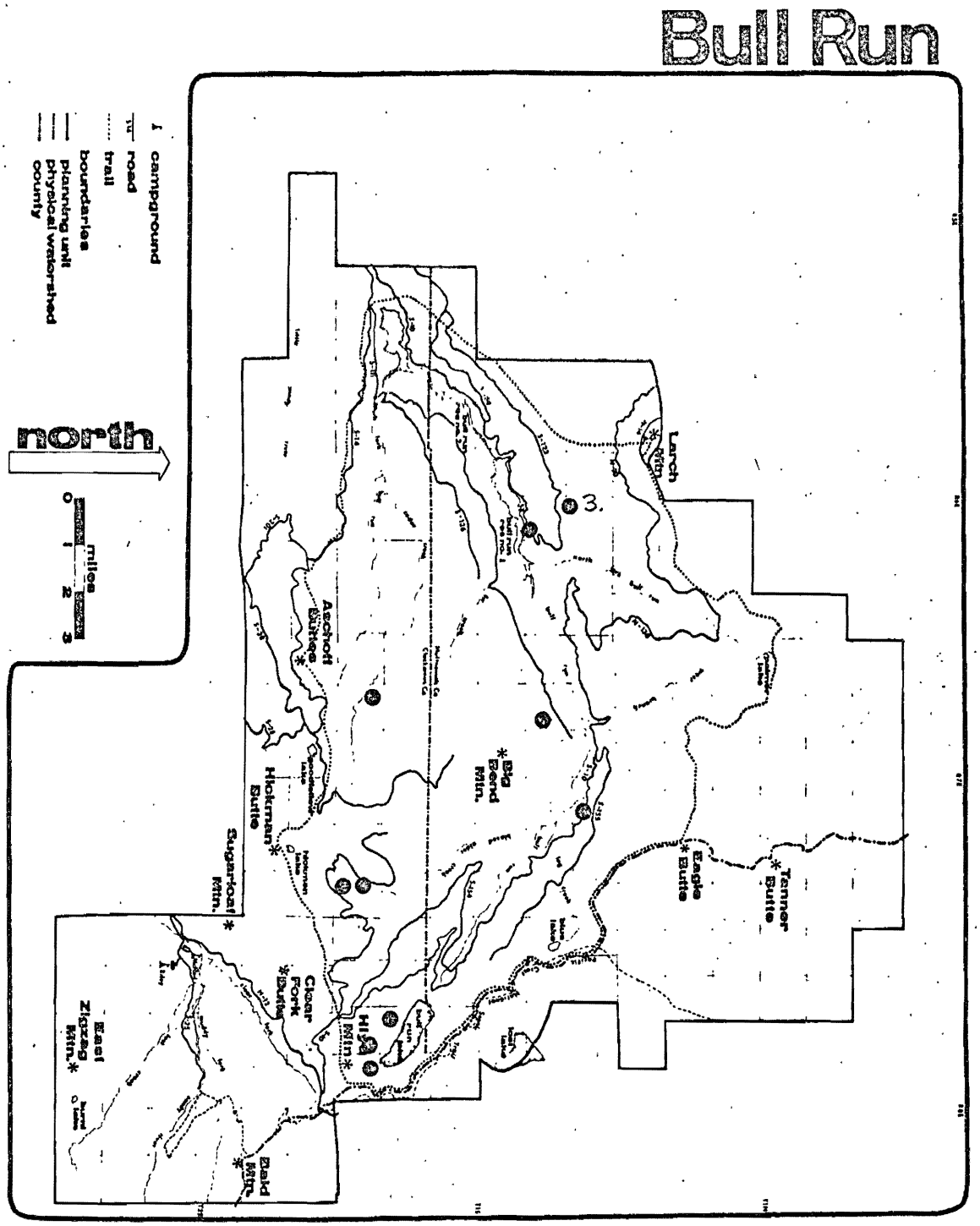
Thomomys monticola (Mountain pocket gopher)

T. monticola occurs mainly in the Cascade and Coast Ranges in Oregon (Hall and Kelson, 1959). This fossorial rodent occupies the Lower Sonoran to Canadian life zones, and consumes roots, tubers, and bulbs encountered in its extensive digging activities (Ingles, 1965; Larrison, 1976). The histograms (Figure 10) indicate that this species' habitat is restricted to dry meadow communities in the Bull Run Planning Unit. The only place the mountain pocket gopher was trapped, or evidence of its activity found, was in a subalpine meadow at 4,400 ft. on Preachers Peak and



Abundance/# of sites of a given plant association trapped.

Figure 10. Distribution of *Thomomys monticola*.



Maps courtesy of the Mt. Hood National Forest.

Figure 11. Location of the Douglas squirrel found in 1973.

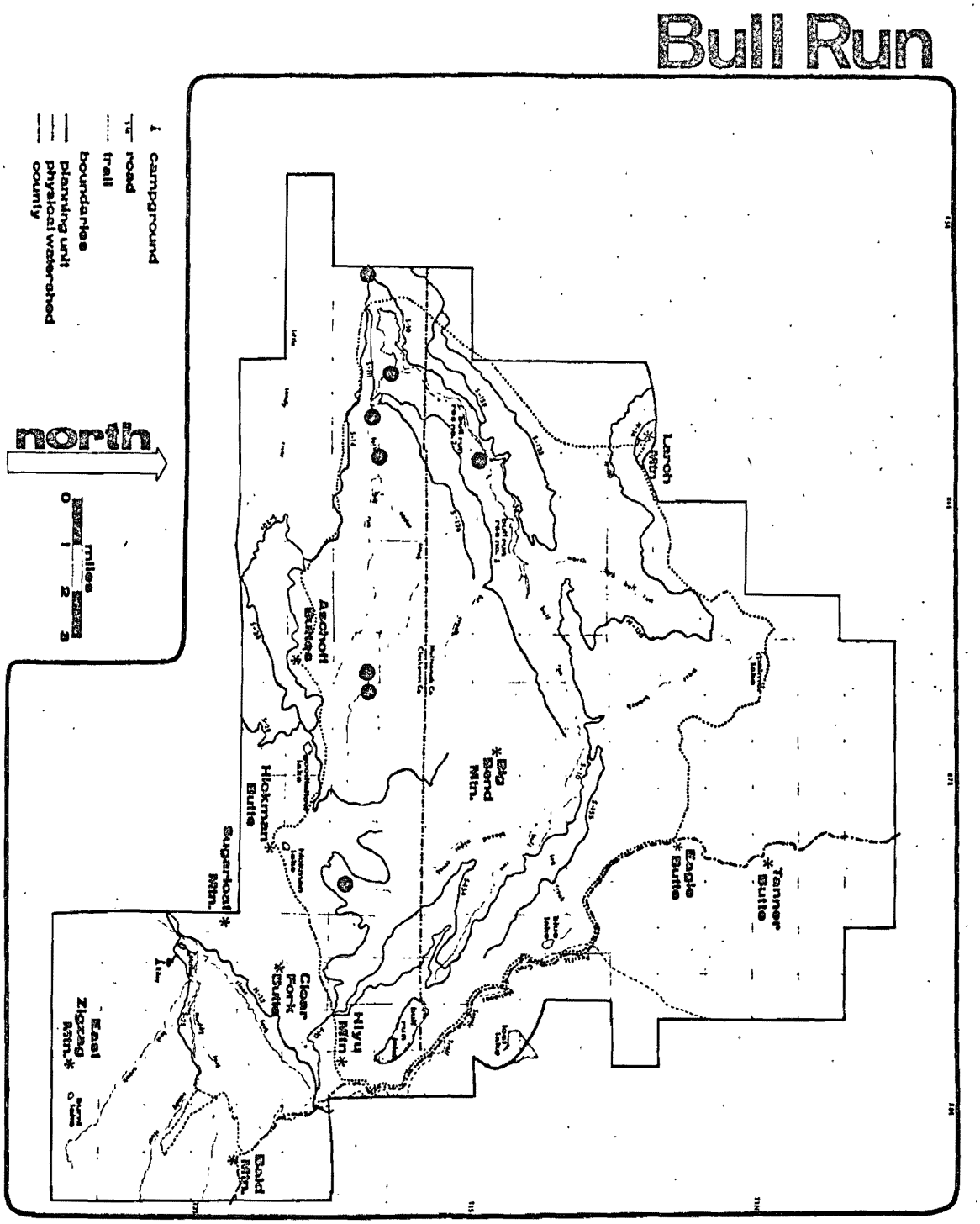
dry open areas on Hickman Butte. No specimens were taken or individuals observed at any other place or in any other habitat type. Hence, it is inferred that these high elevation dry, subalpine meadow situations are preferred by the mountain pocket gopher, and its distribution in the Bull Run Planning Unit is restricted to those areas.

Family Castoridae

Castor canadensis (beaver)

C. canadensis occurs throughout Oregon from coastal streams to the Canadian life zone where suitable ponds, streams, or lakes are available for habitation (Ingles, 1965; Hall and Kelson, 1959). Its main food is the bark and cambium of young trees, branches, and twigs of streamside deciduous species.

Evidence of beaver in the Bull Run Planning Unit was recorded from eight locations up to 2,700 ft. along river and stream banks, and from small drainage ditches in wet meadows (Figure 12). Streamside clippings of vegetation provided evidence of beaver activity, though recent activity was most notable where streams coursed through wet meadows. In the Bull Run Planning Unit, Columbia River basalt bedrock is exposed in most places where the streams flow rapidly down the mountains. In these areas, beaver clippings were found, however, the clippings appeared old. On the other hand, where streams cut through wet meadows



Maps courtesy of the Mt. Hood National Forest.

Figure 12. Location of beaver activity found in 1973.

of small slope angle, mud banks were present and provided suitable conditions for burrowing. The greatest area of beaver activity was found on Cedar Creek in just such a situation. Fresh clippings (with that year's deciduous leaves present), scats, dams, and runways into streamside vegetation were found. Small (1-2 ft.) drainage ditches in wet meadows, such as Deer Meadows, were dammed by beavers also.

Family Cricetidae (Subfamily Cricetinae)

Peromyscus maniculatus (Deer mouse)

P. maniculatus occupies almost all habitats and life zones throughout Oregon (Ingles, 1965; Hall and Kelson, 1959). The deer mouse consumes a wide variety of foods including insects, seeds, and fruits, but seldom eats grasses, leaves, and bark as do the microtine species (Ingles, 1965). This species is easily identified by large ears, eyes, and a relatively long bicolored tail.

Twenty-nine specimens were collected from 62.5% of all trap sites ranging in elevation from 2,000 ft. to 4,400 ft. in both life zones and climax zones found in the Bull Run Planning Unit. The deer mouse was the second most commonly collected small mammal in this study. The range of physical and biotic conditions present within the Bull Run area do not seem to limit this common species' distribution. The only plant association in which the deer mouse

was not captured is the wet meadow community. All other plant associations in both the *Tsuga heterophylla* and *Abies amabilis* zones contained this mammal. High trap success occurred in talus communities, dry sites, and dry meadow communities (Figure 13).

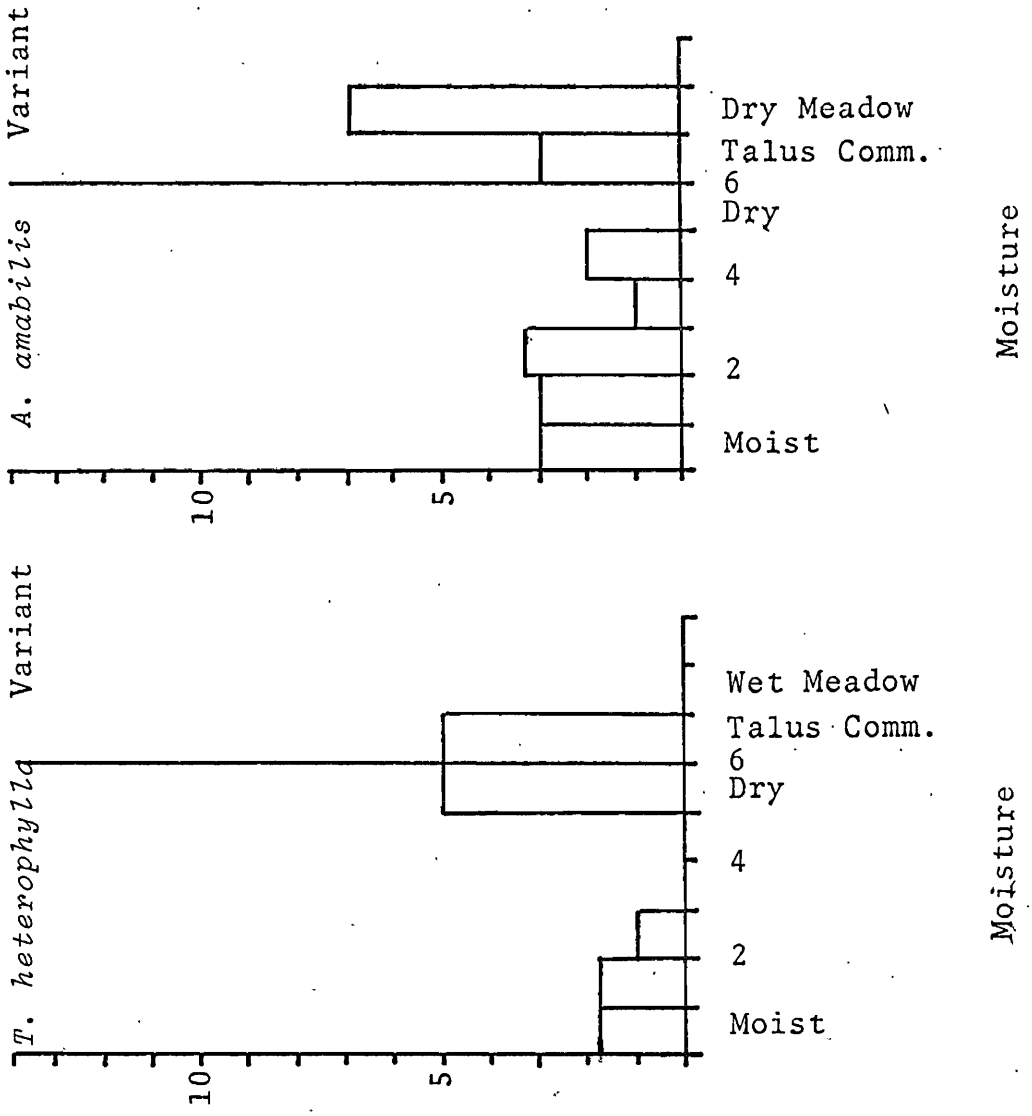
Neotoma cinerea (Bushy-tailed wood rat)

N. cinerea is found throughout Oregon in forested and non-forested regions, generally around rock outcrops or abandoned buildings (Ingles, 1965; Larrison, 1976; Hall and Kelson, 1959). Insects, seeds, bark, and berries are consumed by the bushy-tailed wood rat in the Upper Sonoran, Transition, and Canadian life zones. Five *N. cinerea* were captured in snap traps in the little-used cabins on the shore of Bull Run Lake. During my seven-week stay at these cabins, 19 *N. cinerea* were live trapped and removed from the buildings. One *N. cinerea* was live-trapped in a block-field or talus slope in the Bull Run Research Natural Area (Figure 14).

Subfamily Microtinae

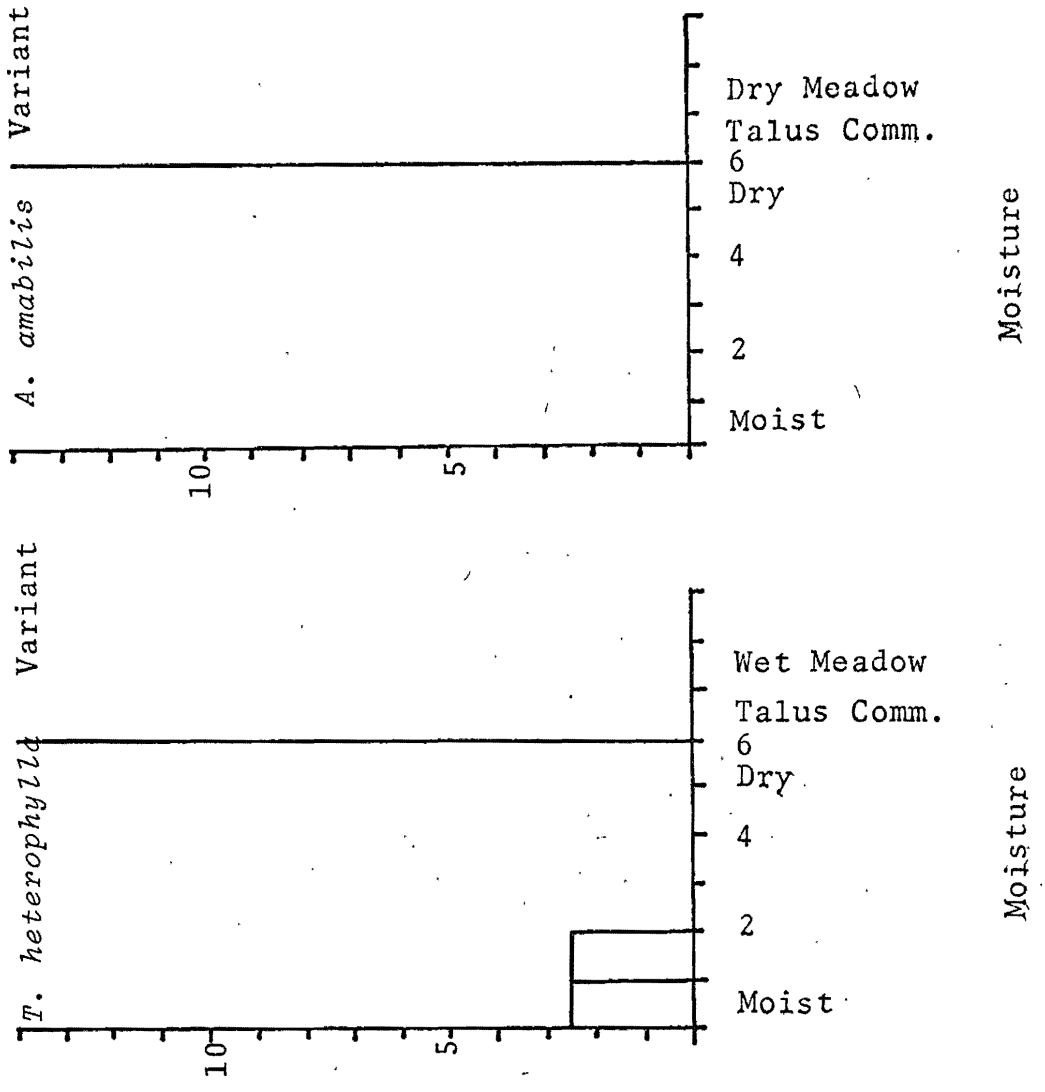
Clethrionomys occidentalis (Red-backed mouse)

C. occidentalis is found in forested habitats in western Oregon from the Cascade Mountains to the coast (Ingles, 1965; Hall and Kelson, 1959; Maser, 1970). The red-backed mouse consumes green vegetation, seeds, fungi, bark, and some insects (Larrison, 1976). This species was



Abundance/# of sites of a given plant association trapped

Figure 13. Distribution of *Peromyscus maniculatus*



Abundance/# of sites of a given plant association trapped.

Figure 14. Distribution of *Neotoma cinerea*.

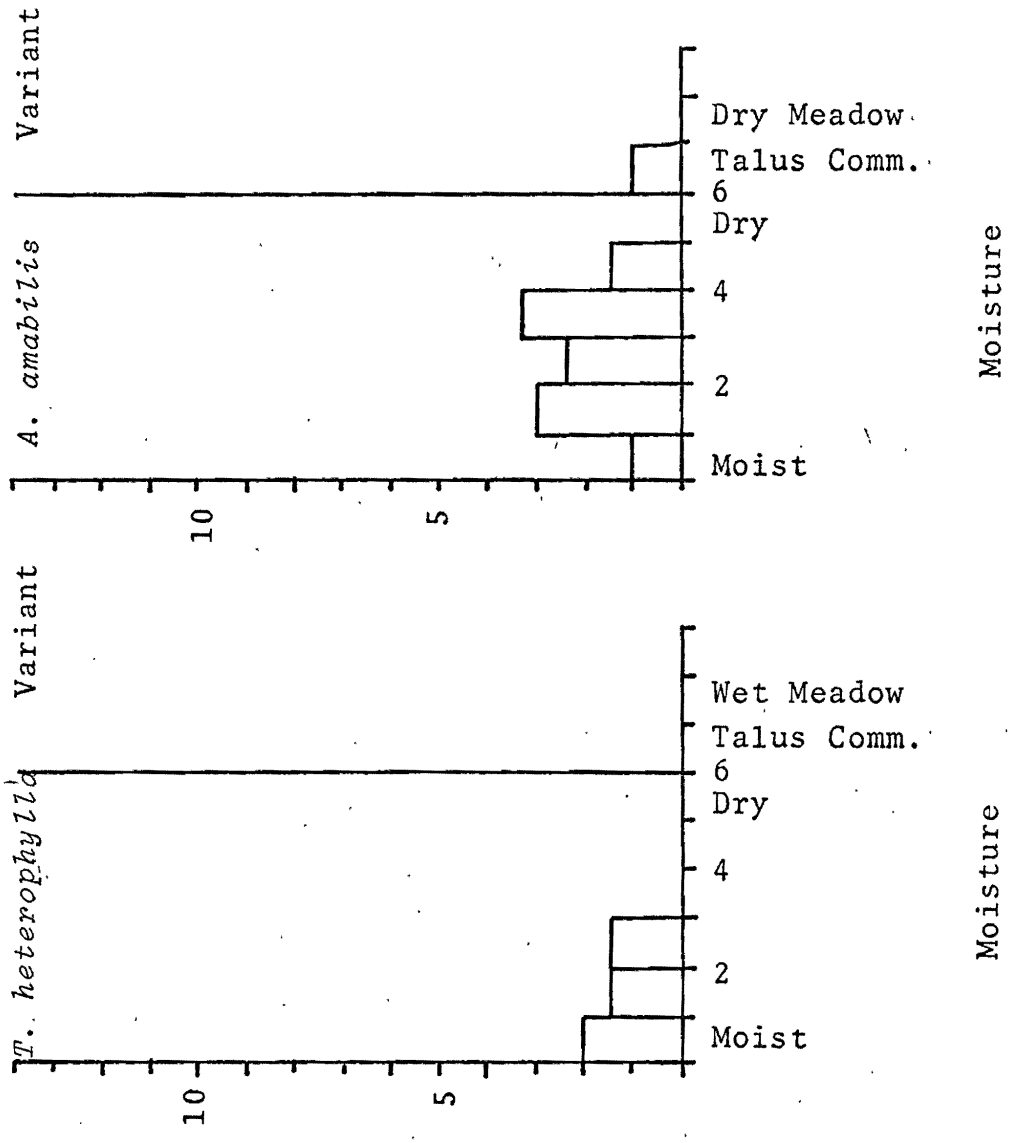
trapped in 50% of all sites; 16 specimens were collected. Identification included the reddish dorsum, and a posteriorly projecting palatine spine on the skull. *C. occidentalis* occurs in a wide range of plant associations and moisture regimes in the Bull Run Planning Unit, both in the *T. heterophylla* and *A. amabilis* zones. Specimens were not taken from open dry or wet meadows, although the vegetation around talus slopes at higher elevations yielded one individual (Figure 15).

Microtus longicaudus (Long-tailed vole)

M. longicaudus occurs throughout Oregon except for the Willamette Valley (Ingles, 1965; Hall and Kelson, 1959; Maser, 1970). The long-tailed vole is found in willow clumps along streams and in wet meadows in the Transition and Canadian life zones. Only one specimen was captured during this study. It was taken at Deer Meadows in the willows surrounding this wet meadow (Figure 16). With 12,096 total trap nights throughout a variety of plant associations, a single specimen was taken only from a wet meadow.

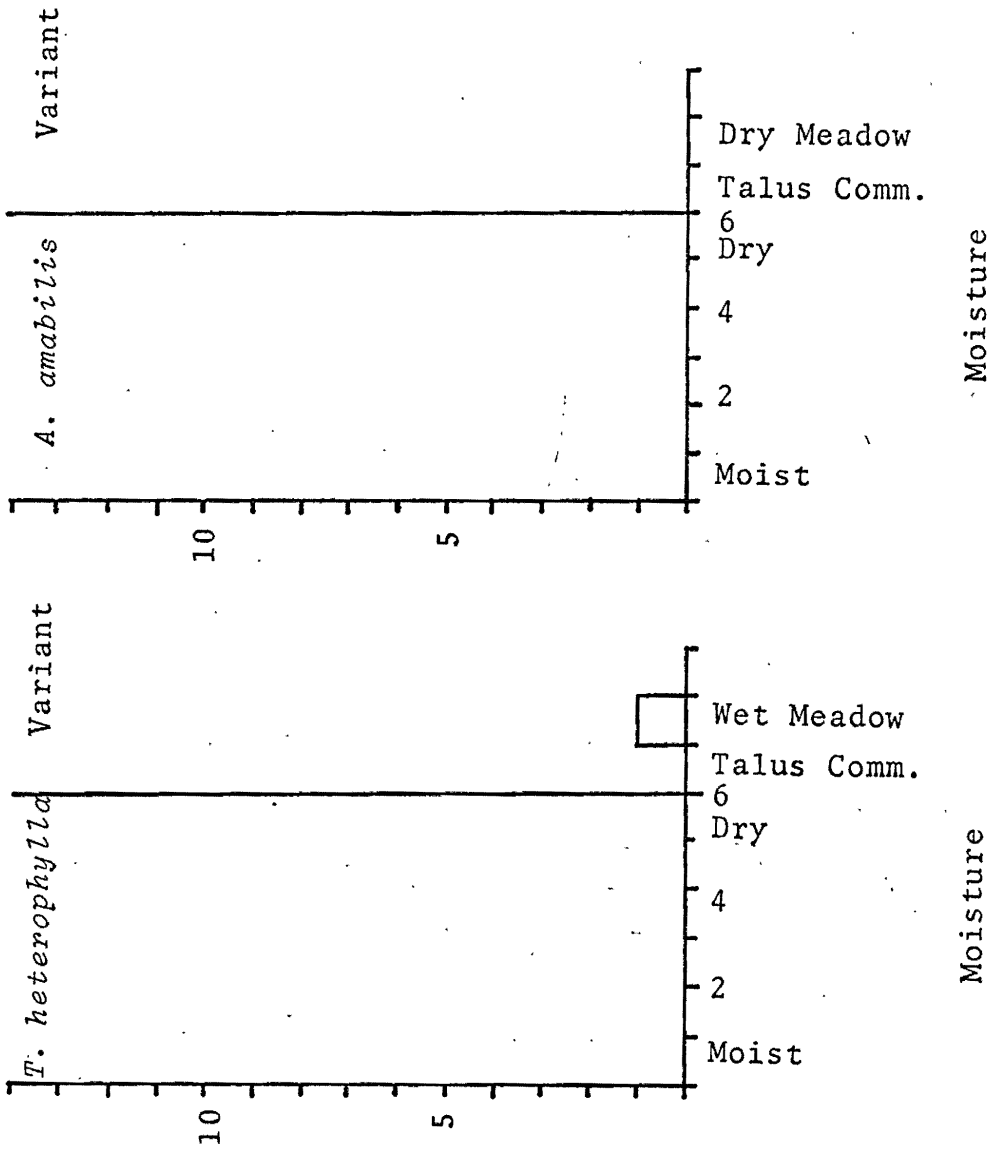
Microtus oregoni (Creeping vole)

M. oregoni occupies approximately the western third of Oregon from the Transition to the Hudsonian life zone (Ingles, 1965; Hall and Kelson, 1959; Maser, 1970). The creeping vole is said to inhabit almost all conceivable



Abundance/# of sites of a given plant association trapped.

Figure 15. Distribution of *Clethrionomys occidentalis*.



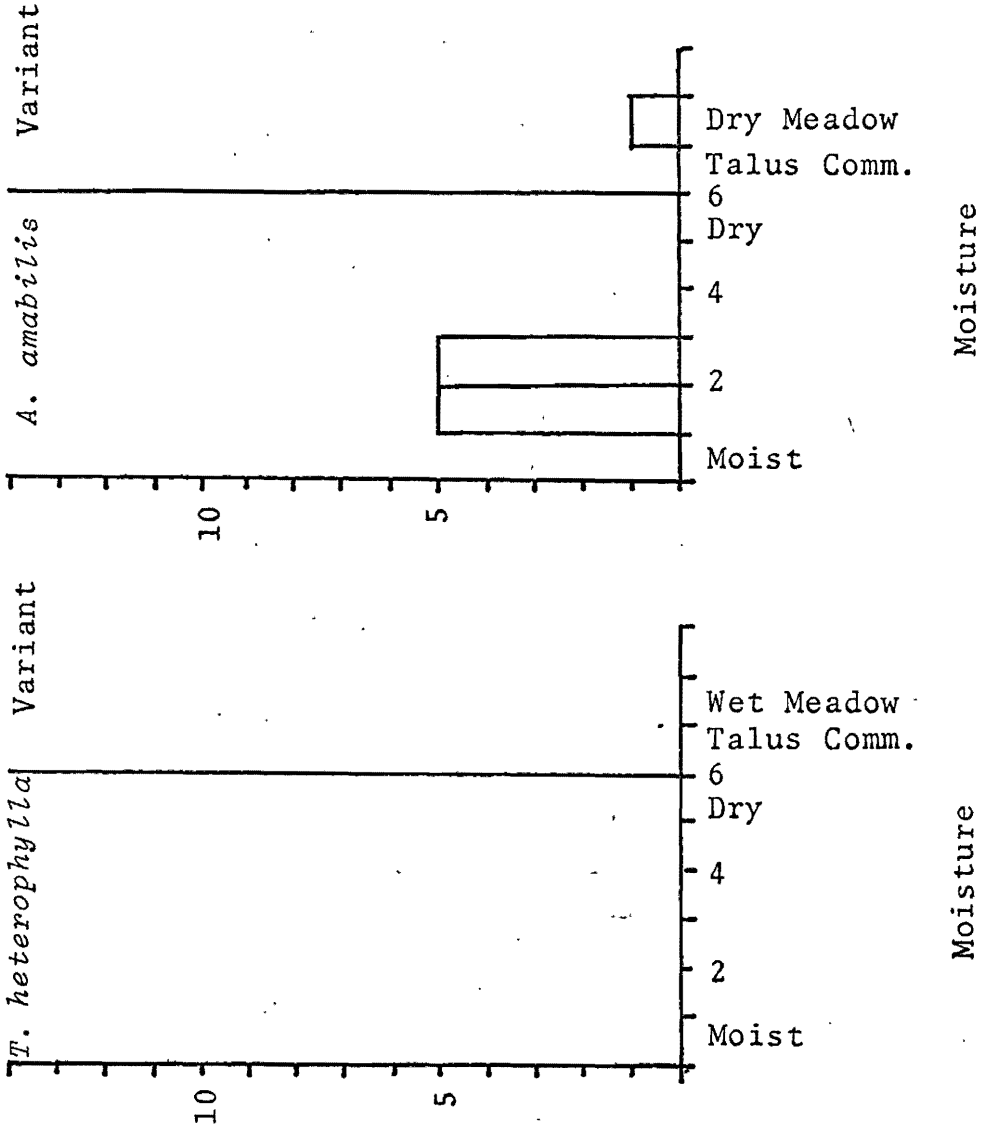
Abundance/# of sites of a given plant association trapped.

Figure 16. Distribution of *Microtus longicaudus*.

mouse habitats, and consumes green vegetation and grasses (Ingles, 1965). Six *M. oregoni* were obtained from two trap lines in the Bull Run Planning Unit. These mice were taken from high elevation, open meadow habitats. One individual was taken from 4,400 ft. on Preachers Peak in a dry meadow community, and the others from a moist, meadow, shrub habitat with clumps of conifers at approximately 4,000 ft. (Figure 17). Though *M. oregoni* is purported to occur in most habitats, this may not be the case in Bull Run. No creeping voles were taken in the *T. heterophylla* zone; only open meadow-like situations in higher elevation habitats yielded this species.

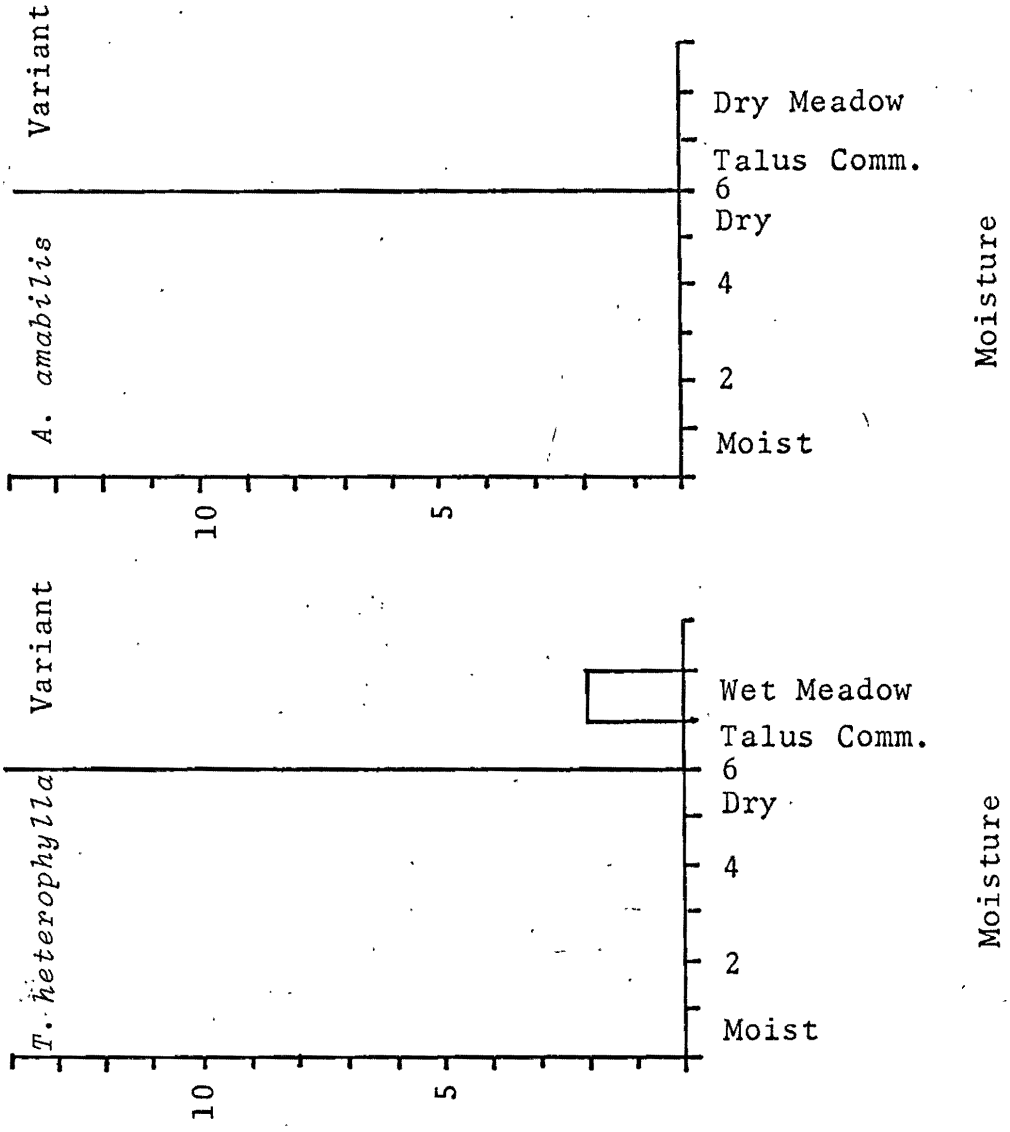
Arvicola richardsoni (Water vole)

A. richardsoni occurs in the Cascade Mountains and extreme eastern portions of Oregon (Ingles, 1965; Hall and Kelson, 1959; Maser, 1970). It occurs in the Canadian and Hudsonian life zones along streams and in marsh habitats. This vole eats green vegetation, and was trapped in only one plant association in the Bull Run Planning Unit. Two individuals were taken from the willows and spirea surrounding Deer Meadows at approximately 2,700 ft. Identification was made by the thick non-wettable fur of the water vole (Figure 18).



Abundance/# of sites of a given plant association trapped.

Figure 17. Distribution of *Microtus oregoni*.



Abundance/# of sites of a given plant association trapped.

Figure 18. Distribution of *Arvicola richardsoni*.

Family Zapodidae

Zapus trinotatus (Pacific jumping mouse)

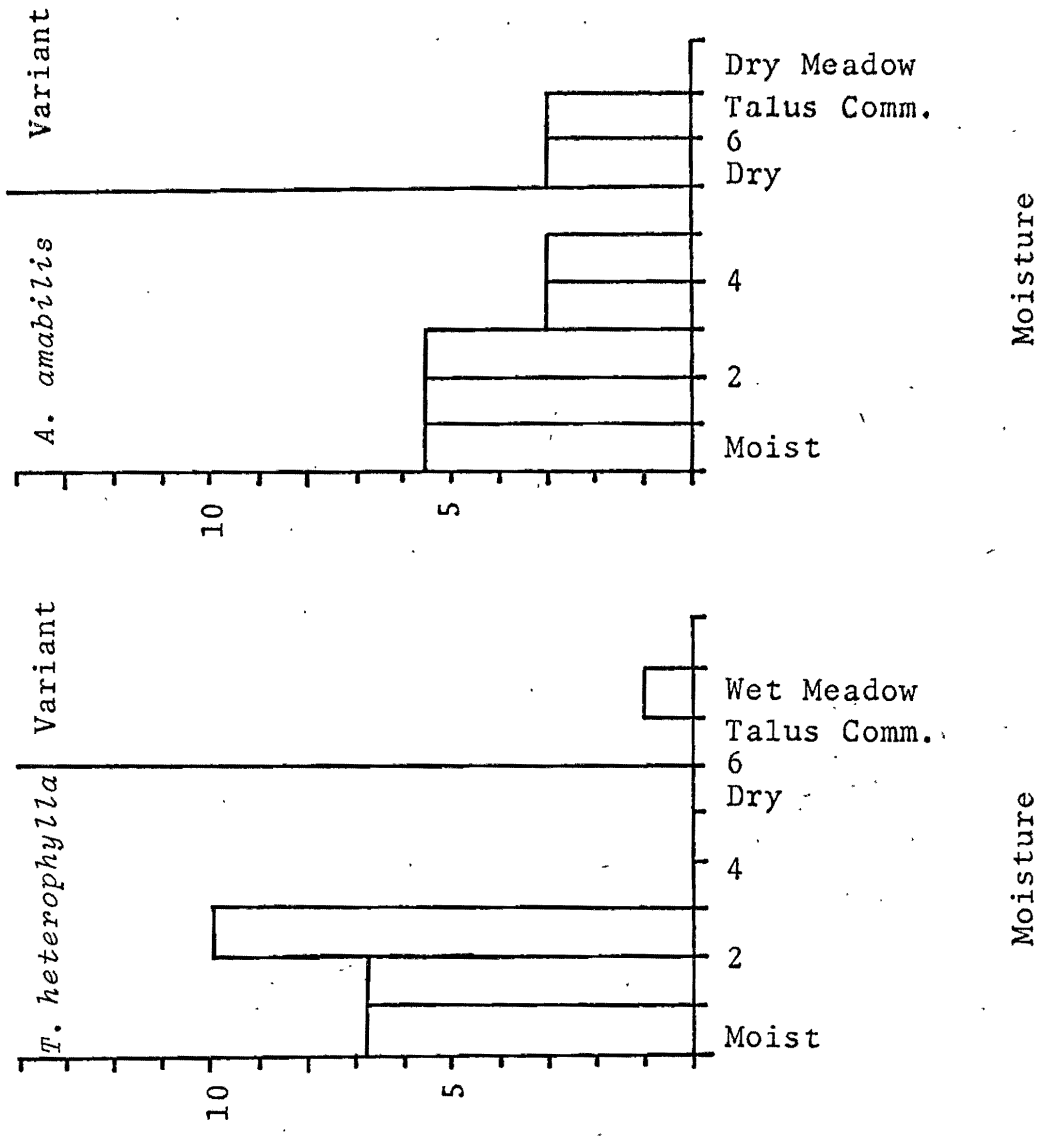
Z. trinotatus occurs in the Transition and Canadian zones of the Cascade Mountains and Coast Range of Oregon (Ingles, 1965; Hall and Kelson, 1959). It is said to prefer "grassy wet places" and consume mainly grass seeds (Ingles, 1965). The Pacific jumping mouse is easily recognized by its long hind feet, orangish sides, and white venter with a tinge of orange.

Thirty-eight *Z. trinotatus* were taken in Museum Special snap traps, more than any other species of small mammal taken. The Pacific jumping mouse was captured in 50% of all trap sites. Contradictory to its purported grassy habitat preference, this species was trapped from 2,000 ft. to 4,400 ft. in both forested and non-forested regions. *Z. trinotatus* was most prevalent in moist areas both at low and high elevations, including one specimen taken from a wet meadow community (Figure 19). However, dry sites such as talus communities, dry meadow communities, and the dry *Abies amabilis/Xerophyllum tenax* plant association were occupied.

Family Erethizontidae

Erethizon dorsatum (Porcupine)

E. dorsatum is found throughout most of Oregon east of the Coast Range. It occupies the Transition and



Abundance/# of sites of a given plant association trapped.

Figure 19. Distribution of *Zapus trinotatus*.

Canadian life zones, and feeds on herbs, shrubs, and preferably the bark of coniferous trees (Ingles, 1965; Larrison, 1976; Hall and Kelson, 1959). *E. dorsatum* was seen only twice during the course of this study while driving along Bull Run Reservoir #2. Both individuals quickly ran off into the underbrush as the car approached.

Order Carnivora

Family Ursidae

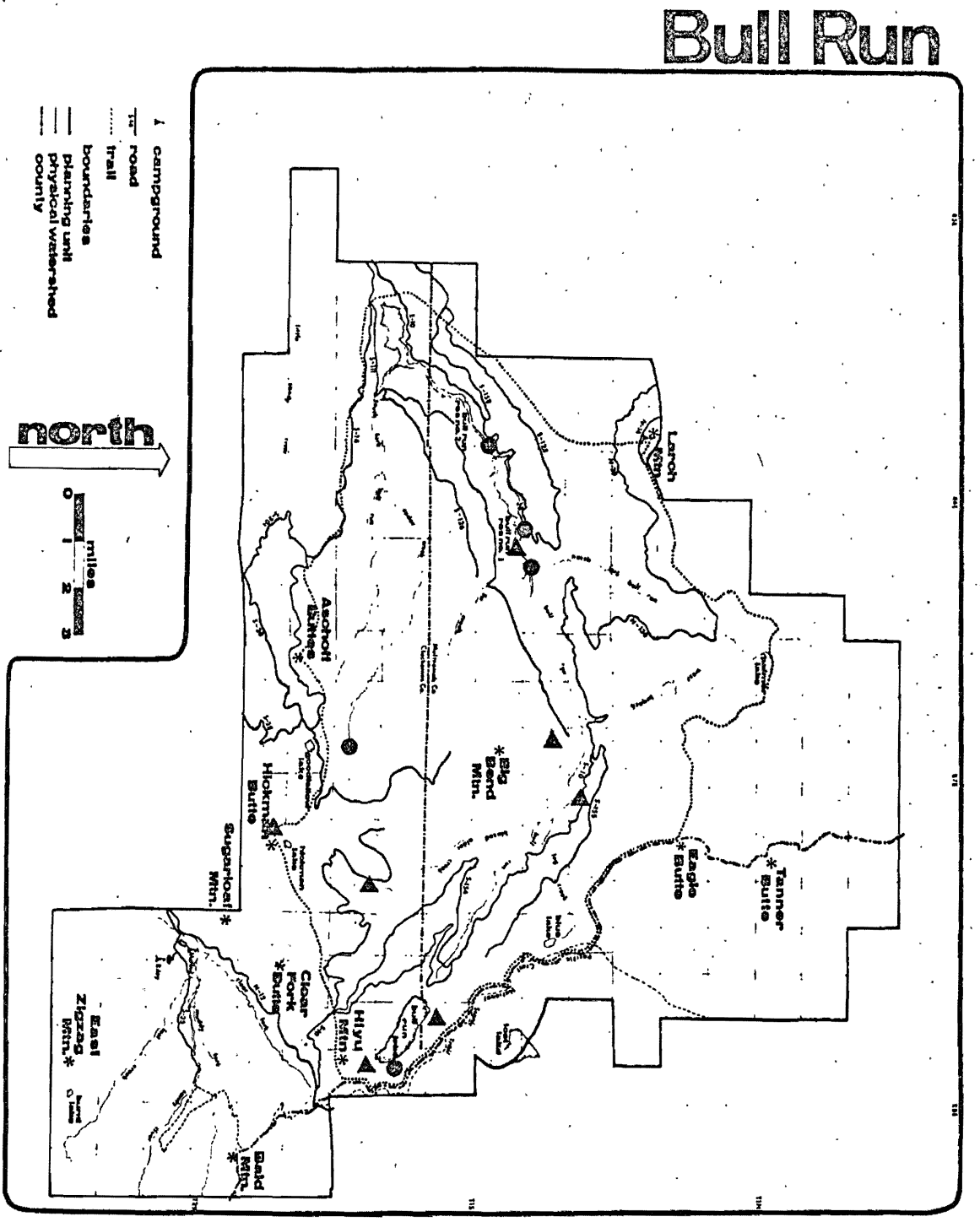
Ursus americanus (Black bear)

U. americanus occurs in the forested regions of the Transition and Canadian life zones in western Oregon and parts of northeastern and central Oregon. Black bears are omnivorous eating small rodents, fish, insects, roots, berries, nuts, and seeds (Ingles, 1965; Hall and Kelson, 1959). The black bear was seen once on Hickman Butte in a thick stand of *Vaccinium* sp. during the Fall. This species was evident throughout the Bull Run Planning Unit from scats. Scats always contained large quantities of *Vaccinium* sp., berries, leaves, and twigs (Figure 20).

Family Procyonidae

Procyon lotor (Raccoon)

P. lotor is found throughout Oregon in all life zones except the Hudsonian (Ingles, 1965). This plantigrade creature is omnivorous in habit often frequenting the banks



Maps courtesy of the Mt. Hood National Forest.

Figure 20. Location of raccoon (●) and black bear (▲) found in 1973.

of streams, ponds, and lakes (Ingles, 1965; Larrison, 1976; Hall and Kelson, 1959). *P. lotor* was identified only from tracks along Bull Run River and Bull Run Lake, and scats along banks of some of the major tributaries (Figure 20).

Family Mustelidae

Mustela erminea (Least weasel)

M. erminea is found in the Canadian and Hudsonian life zones of the Coast Range, Cascade Mountains, and the Wallowa Mountains (Ingles, 1965; Hall and Kelson, 1959). This small mustelid preys on rodents, birds, and insects at high elevation. One sighting was recorded by an informant at the houses on Bull Run Reservoir #1.

Lutra canadensis (River otter)

L. canadensis inhabits rivers, lakes, and marshes of almost the entire state of Oregon (Ingles, 1965; Hall and Kelson, 1959). The river otter consumes crayfish, frogs, fish, and insects. One sighting of a river otter was made at the upstream end of Reservoir #1 at dusk during the early fall.

Family Felidae

Felis rufus (Bobcat)

F. rufus occurs throughout Oregon in almost all life zones and habitat types. It is a predator on small rodents, rabbits, and occasionally deer and birds (Ingles, 1965;

Hall and Kelson, 1959; Larrison, 1976). I was informed of one individual during the early Fall of 1973 in the Bull Run Planning Unit.

Order Artiodactyla

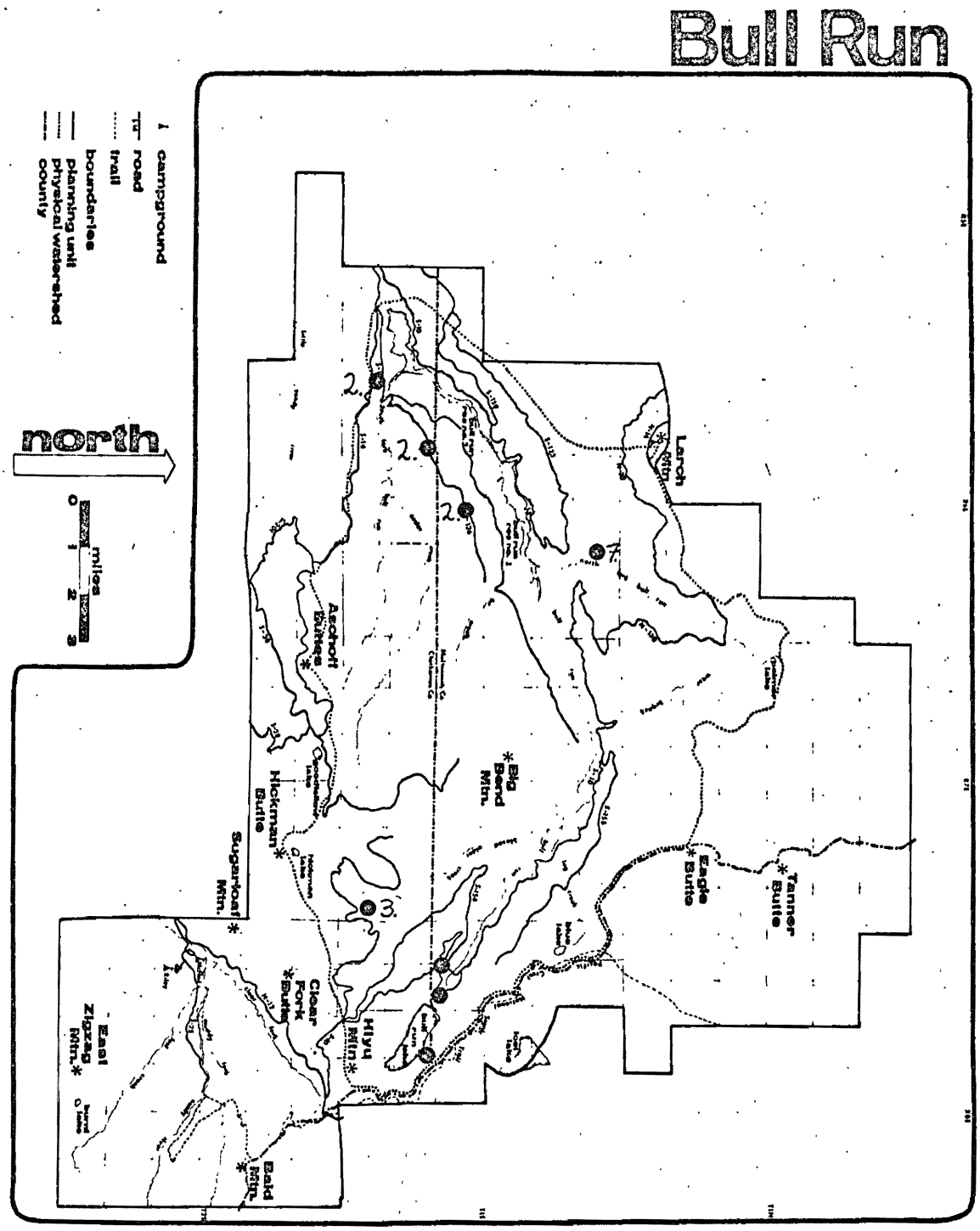
Family Cervidae

Odocoileus hemionus columbianus (Black-tailed deer)

O. hemionus columbianus occurs throughout the western third of Oregon from the Transition to Hudsonian life zone (Ingles, 1965; Hall and Kelson, 1959). The black-tailed deer is a browser, and though deep forests are occupied, populations are more dense in clear cut openings (Edgerton, 1972). The Bull Run Planning Unit has been logged commercially for 20 years with resultant enhancement of herb and shrub browse. This has resulted in increases in deer populations. Crouch (1974) states

> ...Clearcutting and slash burning seem to be completely adequate, and certainly the most practical means, for perpetuating deer habitat - and at no cost to wildlife managers. No other improvements to promote deer are required in coast range forests as long as present or similar timber-management procedures continue, because far more deer will be produced as surplus than could possibly be taken under current hunting regulations.

The deer are also not subject to as heavy hunting pressure as in regions outside the protected Division. Numerous black-tailed deer were sighted and tracks found during this study from approximately 1,000 ft. to 3,500 ft. (Figure 21).



Maps courtesy of the Mt. Hood National Forest.

Figure 21. Location of black-tailed deer observed in 1973.

DISCUSSION

During the summer and early fall of 1973, I found no evidence of threatened or endangered mammals in the Bull Run Planning Unit. The Planning Unit is included in the distribution of the wolverine (*Gulo luscus*) which is considered a threatened mammal in Oregon.[3] Yocom (1973) stated that the wolverine was never common in Oregon. However, Yocom (1974) listed 8 verified sightings of wolverine in Oregon with "one seen about 9 miles southeast of Mt. Hood" being the closest to Bull Run. Two wolverine sightings have been reported in the Blazed Alder Creek and Big Bend Moutain regions of the Bull Run Planning Unit (Kirk Horn, personal communum). Logging in the Bull Run Planning Unit is harmful to potential or actual wolverine habitat (Ingram, 1973). Ingram states "Logging and intensive human activity in the limited habitat of the wolverine is detrimental to the population."

The Columbian white-tailed deer (*Odocoileus virginianus leucurus*) is considered an endangered subspecies in the United States.[3] The distribution is close to Bull Run, but the white-tailed deer's habitat is mainly lowland marshes (Ingles, 1965). The occurrence of this species in the Bull Run has not been reported.

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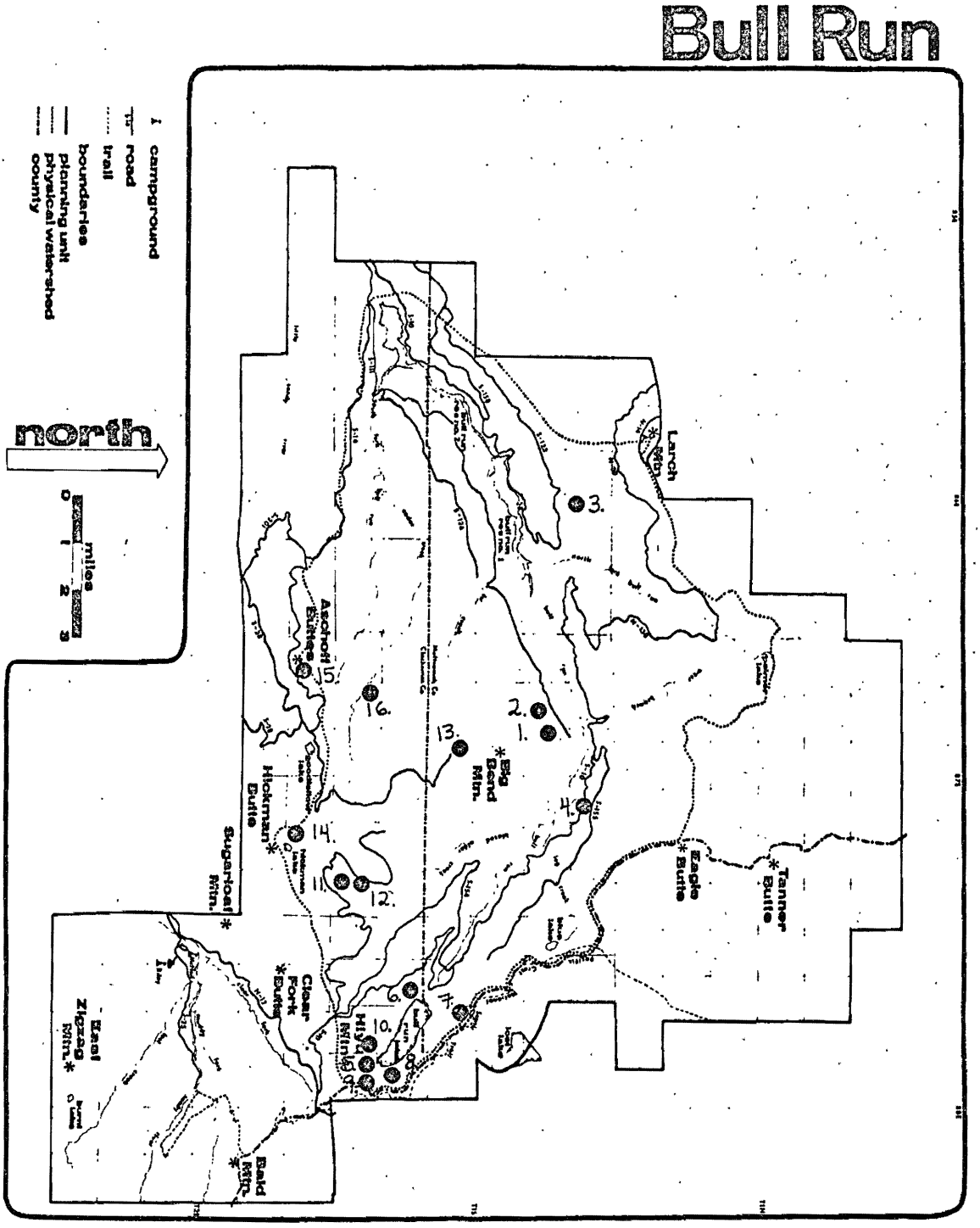
[3] Task force composed of persons from the U. S. Bureau of Sport Fisheries and Wildlife, U. S. Forest Service, Bureau of Land Management, Oregon Wildlife Commission and Agricultural Experimental Station at Oregon State Univ.



Maps courtesy of the Mt. Hood National Forest.

Figure 22. Location of 16 trap sites in the Bull Run Planning Unit.

The red fox (*Vulpes fulva cascadensis*), pine marten (*Martes americana*), and fishor (*Martes pennanti*) are all considered as status undetermined in Oregon.[3] Observations of both the red fox and pine marten have been made in the Bull Run Reserve (Kirk Horn, personal communum). The fisher has not been reported for the Bull Run area even though seemingly good habitat is present (Ingram, 1973).

The cougar (*Felis concolor*), the gray squirrel (*Sciurus griseus*), and the mountain beaver (*Aplodontia rufa*) are considered as "unique" species in Oregon.[3] Observations of the cougar, and evidence of the mountain beaver have been reported for the Bull Run Planning Unit (Kirk Horn, personal communum). However, evidence of the gray squirrel has not been recorded even though distribution maps indicate that it should be present (Hall and Kelson, 1959).

The study of mammals of the Bull Run Planning Unit presented here has been basically a discussion of mammal populations in old growth forest or undisturbed habitat. Approximately 20 percent of the forest in the Bull Run Reserve has been clear cut, leaving large tracts of logging refuse and different stages of regenerating forest. This provides an ideal area for studying effects of habitat destruction on mammal populations, and the relation of certain mammals to successional stages of forest development.

Clear cut logging results in an extraordinary change in physical and biotic parameters in a given geographical unit. Logging effects an increase in light intensity on the forest floor, decreased moisture retention capacity of the soils (Fredriksen, 1974), destruction of heavy duff and litter habitat, a distinct change in plant species composition, and a simplification of plant community structure.

> Timber harvesting creates residues of both living and non-living material...or more properly stated, it transforms residues that occur naturally by increasing some and decreasing others...increased development of invasive plants, defective trees, herbs, shrubs, snags, unmerchantable logs, standing snags, course limbs, twigs, leaves....[4]

However, the increased availability of light to the forest floor gives rise to greater productivity of pioneer species such as *Senecio sylvaticus* and *Epilobium angustifolium* (Franklin, 1973) which provide excellent browse for deer (Edgerton, 1972) and food for many small mammals. Clear-cut logging causes a destruction of habitat, or increase in preferred habitat depending upon the specificity of a species to old-growth forest.

Tevis (1956) studied the relationship between clear cut logging, subsequent successional stages, and small mammal population dynamics in Douglas fir (*Pseudotsuga menziesii*) forests of the Trinity Alps of Northern California. The response of small mammal populations to logging

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[4] Environmental Effects of Forest Residues Management in the Pacific Northwest, Pacific Northwest Forest and Range Experimental Station.

varied depending upon the species. The big-eared mouse (*Peromyscus* sp.) was excluded from forest habitats but invaded clear cuts with dense shrub and small tree habitats. Seed eaters such as *Peromyscus maniculatus* increase population densities after an initial lag compared to virgin forests. Immediately after clear cutting *Peromyscus* populations were roughly equal to virgin forest populations with the invasion of weed and brush plant species. Mammal species such as *Tamiasciurus douglassi*, *Glaucomys sabrinus*, and *Phenacomys longicaudis* that depend more on mature forests for food and shelter decreased to zero in clear cut regions.

Much field work has been done on sympatry since the ideas of Volterra and Gause were formulated into the competitive exclusion principle. This research has centered around elucidation of mechanisms by which sympatric species isolate themselves ecologically to reduce the intensity of competition and allow for coexistence (Brown, 1973; Cody, 1968; Cody, 1974; Kunz, 1973; McCloskey, 1975; Meserve, 1976; Murie, 1971; Rosenzweig, 1966). Cody (1974) discussed coexistence mechanisms in birds as segregation on a geographic scale, by altitude, between-habitats or difference in habitat preference, and within-habitat segregation as differences in food or feeding behavior.

Examples of non-overlapping geographic ranges in congeneric mammals are numerous - *e.g*, *Zapus trinotatus* and

Z. princeps (Hall and Kelson, 1959). O'Farrell (1975) discussed altitudinal clines of small mammals in eastern Washington, where deer mice (*Peromyscus* sp.) replace pocket mice (*Perognathus* sp.) at higher elevations. Murie (1971) studied behavioral mechanisms in habitat segregation of two microtine species with overlapping geographic ranges, in which *Microtus pennsylvanicus* occupied "moist to wet, lowland areas and *Microtus montanus* inhabits dry grasslands." Brown and Lieberman (1973) investigated difference in food and "horizontal" foraging activity in granivorous rodents in Californian sand dune habitats, and suggested that the seed resource is divided among granivores by seed size which correlated directly with rodent body size. Horizontal foraging activity was different in different rodent species. For example, *Perognathus longimembris* foraged under shrubs while *Dipodomys* sp. foraged for the same resource in open areas resulting in ecological isolation and reduced competitive interaction.

Trap data I collected (Appendix B, C) were presented graphically in two ways. First, the distribution of small mammal species was presented by plotting abundance against position on a moisture gradient (plant associations as indicators of moisture availability) for each species in the *T. heterophylla* and *A. amabilis* climax zones (Figures 4, 5, 6, 7, 9, 10, 13-19). Trap data graphed in this manner indicates habitat preference with respect to moisture

availability, habitat specificity, and possible ecological isolation owing to differences in habitat utilization for each mammalian species. The trap data were then presented by plant association trapped in graphs of abundance *versus* species captured (Appendix D). The species composition and abundance revealed by snap-trap methods in plant associations indicates sympatric small mammal species in the two moisture gradients studied. These sympatric species in each plant association are potential or actual competitors, isolated ecologically by a "coexistence mechanism" such as was discussed above, or one not readily apparent to investigators.

Inspection of graphs plotting abundance *versus* position on a moisture gradient (Figures 4-7, 9, 10, 13-19) reveals a broad range of habitat specificity. Examples of habitat specialization are indicated by bar graphs for *Thomomys monticola* which was captured only in dry meadows at high elevations (Figure 10), *Ochotona princeps* in talus communities at low and high elevations (plus one capture in the vegetation close to talus fields, Figures 7,8), *Neurotrichus gibbsii* in moist sites at low elevation (Figures 6, 14), and *Arvicola richardsoni* and *Microtus longicaudus* (Figures 16, 18) in wet meadow communities (Appendix C, note that small numbers of specimens were trapped which limits definite conclusions). Habitat generalism was apparent in the distributions of *Peromyscus maniculatus*

(Figure 13), *Zapus trinotatus* (Figure 19), *Eutamias townsendii* (Figure 9), *Sorex vagrans* (Figure 4), *Sorex trowbridgii* (Figure 5), and *Clethrionomys occidentalis* (Figure 15). The distribution of *Microtus oregoni* with respect to a moisture gradient at high elevation is discontinuous (Figure 7); hence, degree of habitat specialization in this species is unclear.

Narrow habitat utilization curves, such as those of the microtine rodents *Arvicola richardsoni* (Figure 16) and *Microtus longicaudus* (Figure 18) suggest a "coexistence mechanism" between closely related microtines, such as *Microtus oregoni* and *Clethrionomys occidentalis*, whose habitat utilization curves do not overlap with wet meadow communities (Figure 15, 17). The curves of *C. occidentalis* and *M. oregoni*, two grass-eaters, do overlap with the possible consequence of competition. However, *M. oregoni* was trapped only in high elevation meadows while *C. occidentalis* shows broad habitat utilization at both high and low elevations with a preference for moist habitats. Ecologically closely related species such as *Peromyscus maniculatus* and *Zapus trinotatus*, two seed-eaters, plus *Sorex vagrans* and *S. trowbridgii*, two insectivores, do not clearly segregate ecologically by difference in habitat utilization (Figures 3, 4, 13, 19).

SUMMARY

This study of mammals of the Bull Run Planning Unit has a dual character. Mammals of special scientific or natural history interest, and mammals whose populations are threatened or endangered have been sought. Mammals of low population numbers are inherently difficult to locate, and no evidence of these threatened or endangered species was found in this study. The distribution and abundance of mammals in the Bull Run Planning Unit was also investigated. A series of graphs presents the species composition and abundance of small mammals in all plant associations trapped, others revealed habitat utilization of small mammals with respect to plant associations along a moisture gradient in the *T. heterophylla* and *A. amabilis* climax zones. The sympatric species revealed in Figures 24-36 are potential or actual competitors. Difference in habitat utilization is a possible coexistence mechanism for small mammal species trapped. Narrow habitat utilization is evident in graphs drawn for *T. monticola, O. princeps, N. gibbsii, A. richardsoni,* and *M. longicaudus*. Habitat generalism was indicated in utilization curves for *P. maniculatus, Z. trinotatus, E. townsendii, S. vagrans, S. trowbridgii,* and *C. occidentalis*. Overlap in habitat utilization is apparent for these species, and coexistence does not seem to be the result of difference in habitats occupied.

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APPENDIX A

Species List

1. *Sorex vagrans* (vagrant shrew)
2. *Sorex palustris* (water shrew)
3. *Sorex trowbridgii* (Trowbridge's shrew)
4. *Neurotrichus gibbsii* (shrew-mole)
5. *Myotis californicus* (California myotis)
6. *Ochotona princeps* (pika)
7. *Lepus americanus* (snowshoe hare)
8. *Eutamias townsendii* (Townsend's chipmunk)
9. *Spermophilus beecheyi* (California ground squirrel)
10. *Spermophilus lateralis* (golden-mantled ground squirrel)
11. *Tamiasciurus douglassi* (Douglas squirrel)
12. *Glaucomys sabrinus* (northern flying squirrel)
13. *Thomomys monticola* (mountain pocket gopher)
14. *Castor canadensis* (beaver)
15. *Peromyscus maniculatus* (deer mouse)
16. *Neotoma cinerea* (bushy-tailed woodrat)
17. *Clethrionomys occidentalis* (western red-backed vole)
18. *Microtus longicaudus* (long-tailed vole)
19. *Microtus oregoni* (creeping vole)
20. *Arvicola richardsoni* (water vole)
21. *Zapus trinotatus* (Pacific jumping mouse)
22. *Erethizon dorsatum* (porcupine)
23. *Ursus americanus* (black bear)

24. *Procyon lotor* (raccoon)
25. *Mustela erminea* (least weasel)
26. *Lutra canadensis* (river otter)
27. *Felis rufus* (bobcat)
28. *Odocoileus hemionus columbianus* (black-tailed deer) (Ingles, 1965)

Binomial and trinomial nomenclature, and common names used follow Jones (1975) unless stated otherwise.

APPENDIX B

Description of Specific Trap Sites

Site 1

1. Location - Off S111. T1S R7E Sect. 9 NW 1/4 WM.
2. Elevation - 2,000 ft.
3. Slope angle - 44% or 24°.
4. Aspect - N.
5. Soil type - Gravelly silt loam.[5]
6. Plant associations present (Franklin, 1973).
   a. *Tsuga heterophylla* (western hemlock)/*Polystichum munitum* (sword fern)/*Oxalis oregana* (woodsorrel).
   b. *T. heterophylla/P. munitum.*

Canopy

Pseudotsuga menziesii (Mirbel) Franc. (Douglas fir).[6]

Thuja plicata Donn. (western red cedar).

T. heterophylla (Raf) Sarg.

Small tree and seedling

Acer circinatum Pursh. (vine maple).

T. plicata Donn.

T. heterophylla (Raf) Sarg.

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[5] Soil Survey Report. Bull Run-Sandy Area. Mt. Hood National Forest. Pacific Northwest Region.

[6] Binomial and trinomial nomenclature of vegetation follow Hitchcock and Chronquist (1973).

Shrubs

Berberis nervosa Pursh. (dwarf Oregon grape)

Gaultheria shallon Pursh. (salal)

Oplopanax horridum (Smith) Miq. (devil's club)

Rosa gymnocarpa Nutt. (Little wild rose)

Rubus spectabilis Pursh. (salmonberry)

Vaccinium parvifolium Smith. (red huckleberry)

Herbs indicative of plant associations present

Achlys triphylla (Smith) D. C. (vanilla leaf)

Asarum caudatum Lindl. (wild ginger)

Athyrium filix-femina (L) Roth. (lady fern)

Blechnum spicant (L) Roth. (deer fern)

Linnaea borealis L. (twin flower)

O. oregana Nutt.

P. munitum (Kaulf) Presl.

Tiarella trifoliata L. var. *trifoliata* L. (three-leaved coolwort)

Vancouveria hexandra (Hook) Morr. and Dec. (inside-out flower)

Site 2

1. Location - T1S R7E Sect. 8 NE 1/4 WM.
2. Elevation - 2,000 ft.
3. Slope angle - 55% or 29°
4. Aspect - NNE

5. Soil type - Gravelly silt loam

6. Plant associations present

   a. *T. heterophylla/P. munitum/O. oregana*

   b. *T. heterophylla/P. munitum*

Canopy

P. menziesii (Mirbel) Franco.

T. plicata Donn.

T. heterophylla (Raf) Sarg.

Small tree and seedling

A. circinatum Pursh.

Acer macrophyllum Pursh. (big-leaf maple)

Corylus cornuta Marsh. (California hazel)

P. menziesii (Mirbel) Franco.

T. heterophylla (Raf) Sarg.

Shrubs

B. nervosa Pursh.

O. horridum (Smith) Miq.

R. gymnocarpa Nutt.

V. parvifolium Smith.

Herbs indicative of plant associations present

A. caudatum Lindl.

A. filix-femina (L) Roth.

O. oregana Nutt.

P. munitum (Kauf) Presl.

Site 3

1. Location - T1S R6E Sect. 3 SW 1/4 WM.
2. Elevation - 1,900 ft.
3. Slope angle - 18° or 32.5%
4. Aspect - SE
5. Soil type - Stony loam
6. Plant associations present
   a. *T. heterophylla/P. munitum*
   b. *T. heterophylla/Rhododendron macrophyllum* (rhododendron)/*B. nervosa*

Canopy

P. menziesii (Mirbel) Franco

T. heterophylla (Raf) Sarg.

Small tree and seedling

A. circinatum Pursh.

T. heterophylla (Raf) Sarg.

Shrubs

B. nervosa Pursh.

G. shallon Pursh.

R. gymnocarpa Nutt.

Sambucus racemosa L. (red elderberry)

V. parvifolium Smith

Herbs indicative of plant associations present

Goodyera oblongifolia Raf. (rattlesnake-plantain)

P. munitum (Kaulf) Presl.

T. trifoliate L. var. *trifoliata* L.

Site 4

1. Location - Off S10. T1S R7E Sect. 3 SE 1/4 WM.
2. Elevation - 2,800 ft.
3. Slope angle - 34.5% or 19°
4. Aspect - S.
5. Soil type - Rubble land (talus slope)
6. Plant associations present
   a. Talus community. *A. circinatum/Cryptogramma crispa* (rock brake)/*Asplenium trichomanes* (maiden hair spleenwort)
   b. *P. menziesii/Holodiscus discolor* (oceanspray)

Canopy

A. macrophyllum Pursh.

P. menziesii (Mirbel) Franco.

T. heterophylla (Raf) Sarg.

Small tree and seedlings

A. circinatum Pursh.

A. macrophyllum Pursh.

C. cornuta Marsh.

P. menziesii (Mirbel) Franco

Shrubs

B. nervosa Pursh.

G. shallon Pursh.

H. discolor (Pursh) Maxin.

O. horridum (Smith) Miq.

Philadelphus lewisii Pursh. (mock orange)

R. gymnocarpa Nutt.

S. racemosa L.

Herbs indicative of plant associations present

A. trichomanes L.

C. crispa (L) R. Br.

Site 5

1. Location - Bull Run Research Natural Area. T1S R8E Sect. 34 NW 1/4 WM.
2. Elevation - 3,200 ft.
3. Slope angle - 19% or 11°
4. Aspect - NW
5. Soil type - Gravelly silt loam
6. Plant associations present
   a. *Abies amabilis* (Pacific silver fir)/*O. horridum* *A. amabilis/Streptopus roseus* (rosy twisted stalk)
   b. *A. amabilis/Vaccinium alaskense* (Alaska blueberry)

Canopy

A. amabilis (Dougl) Forbes

Abies procera Rehder. (noble fir)

Pseudotsuga menziesii (Mirbel) Franco

T. plicata Donn.

T. heterophylla (Raf) Sarg.

Small tree and seedlings

A. amabilis (Dougl) Forbes

T. heterophylla (Raf) Sarg.

Shrubs

Menziesia ferruginea Smith. (false huckleberry)

O. horridum (Smith) Miq.

R. macrophyllum G. Don.

Herbs indicative of plant associations present

A. triphylla (Smith) D. C.

A. filix-femina (L) Roth.

B. spicant (L) Roth.

Smilacina stellata (L) Desf. (star-flowered Solomon's seal)

Tiarella trifoliate L. var. *unifoliata* (Hook) Kurtz. (one-leaved coolwort)

V. hexandra (Hook) Morr. and Dec.

Site 6

1. Location - Bull Run Lake. T1S R8E Sect. 29 NE 1/4 WM.
2. Elevation - 3,200 ft.
3. Slope angle - 57% or 29.5° and 10% or 5.5°
4. Aspect - NNE
5. Soil type - Stony loam
6. Plant associations present
   a. *A. amabilis/V. alaskense*
   b. *A. amabilis/Xerophyllum tenax* (bear grass)

Canopy

A. amabilis (Dougl) Forbes

A. procera Rehder

P. menziesii (Mirbel) Franco

T. plicata Donn.

T. heterophylla (Raf) Sarg.

Small tree and seedlings

A. amabilis (Dougl) Forbes

Alnus sinuata (Regl) Ryb. (sitka alder)

T. plicata Donn.

T. heterophylla (Raf) Sarg.

Shrubs

G. shallon Pursh.

M. ferruginea Smith

R. macrophyllum G. Don.

V. alaskense Howell.

Vaccinium membranaceum Dougl. (big huckleberry).

V. parvifolium Smith

Herbs indicative of plant associations present

Clintonia uniflora (Schult) Kunth. (queen's cup).

Cornus canadensis L. (bunchberry).

L. borealis L.

X. tenax (Pursh) Nutt.

Site 7

1. Location - Preachers Peak. T1S R8E Sect. 21 NW 1/4 WM.
2. Elevation - 4,400 ft.
3. Slope angle - 70% or 35°.
4. Aspect - SSW.
5. Soil type - Stony loam.
6. Plant associations present.
   a. Dry meadow community. *Sedum divergens* (stonecrop)/*Solidago* sp. (goldenrod).

Canopy

A. amabilis (Dougl) Forbes.

A. procera Rehder.

P. menziesii (Mirbel) Franco.

T. plicata Donn.

Small tree and seedlings

A. amabilis (Dougl) Forbes.

A. procera Rehder

A. sinuata (Regl) Ryhd.

P. menziesii (Mirbel) Franco.

T. plicata Donn.

Herbs indicative of plant associations present

S. divergens Wats.

Solidago sp.

Site 8

1. Location - Bull Run Research Natural Area. T1S R8E Sect. 27 SW 1/4 WM.
2. Elevation - 3,200 ft.
3. Slope angle - 21% or 12°.
4. Aspect - WSW.
5. Soil type - Stony loam.
6. Plant associations present.
   a. *A. amabilis/O. horridum.*
   b. *A. amabilis/S. roseus.*
   c. *A. amabilis/V. alaskense.*

Canopy

A. amabilis (Dougl) Forbes.

A. procera Rehder.

P. menziesii (Mirbel) Franco.

T. plicata Donn.

T. heterophylla (Raf) Sarg.

Small tree and seedlings

A. amabilis (Dougl) Forbes.

A. circinatum Pursh.

T. heterophylla (Raf) Sarg.

Shrubs

M. ferruginea Smith.

O. horridum (Smith) Miq.

R. spectabilis Pursch.

V. alaskense Howell.

V. membranaceum Dougl.

V. parvifolium Smith.

Herbs indicative of plant associations present

A. triphylla (Smith) D. C.

A. filix-femina (L) Roth.

C. uniflora (Schult) Kunth.

C. canadensis L.

Gymnocarpium dryopteris (L) Newm. (oak fern).

S. stellata (L) Desf.

T. trifoliata L. var. *unifoliata* (Hook) Kurtz.

Site 9

1. Location - Saddle between Hiyu Mountain and Sentinel

Peak. T1S R8E Sect. 34 NE 1/4 WM.

2. Elevation - 4,000 ft.

3. Slope angle - 24% or 13.5°.

4. Aspect - NW.

5. Soil type - Gravelly silt loam.

6. Plant associations present.

   a. *A. amabilis/O. horridum.*

   b. *A. amabilis/S. roseus.*

   c. *A. amabilis/V. alaskense.*

Canopy

A. amabilis (Dougl) Forbes.

A. procera Rehder.

P. menziesii (Mirbel) Franco.

T. plicata Donn.

T. heterophylla (Raf) Sarg.

Small tree and seedlings

A. amabilis (Dougl) Forbes.

A. sinuata (Regel) Ryos.

T. heterophylla (Raf) Sarg.

Shrubs

M. ferruginea Smith.

O. horridum (Smith) Miq.

R. parviflorus Nutt.

R. spectabilis Pursch.

V. alaskense Howell.

V. membranaceum Dougl.

Herbs indicative of plant associations present

A. triphylla (Smith) D. C.

A. filix-femina (L) Roth.

B. spicant (L) Roth.

C. uniflora (Schult) Kunth.

C. canadensis L.

G. dryopteris (L) Newn.

S. stellata (L) Desf.

T. trifoliata L. var. *unifoliata* (Hook) Kurtz.

Site 10

1. Location - Bull Run Research Natural Area. T1S R8E Sect. 33 NE 1/4 WM.
2. Elevation - 3,500 ft.
3. Slope angle - 55% or 33.8°.
4. Aspect - NE.
5. Soil type - Rubble land (talus slope).
6. Plant associations present.
   a. Talus community. *A. circinatum/C. crispa/A. trichomanes.*
   b. *A. amabilis/G. shallon.*

Canopy

A. amabilis (Dougl) Forbes.

A. procera Rehder.

P. menziesii (Mirbel) Franco.

T. heterophylla (Raf) Sarg.

Small tree and seedlings

A. amabilis (Dougl) Forbes

A. circinatum Pursh.

A. sinuata (Regl) Rybd.

P. menziesii (Mirbel) Franco.

T. plicata Donn.

T. heterophylla (Raf) Sarg.

Shrubs

G. shallon Pursh.

M. ferruginea Smith.

Pachystima myrsinites (Pursh) Raf. (Oregon boxwood).

R. macrophyllum G. Don.

V. alaskense Howell.

V. membranaceum Dougl.

V. parvifolium Smith.

Herbs indicative of plant associations present

A. trichomanes L.

C. crispa (L) R. Br.

Site 11

1. Location - Deer Meadows. T1S R7E Sect. 36 SW 1/4 WM.

2. Elevation - 2,700 ft.

3. Slope angle - 2% or 1°.

4. Aspect - NNE

5. Soil type - Silt loam.

6. Plant associations present.

   a. Wet meadow community. *Camasia quamash* (camas).

Canopy

A. amabilis (Dougl) Forbes.

P. monticola Dougl.

T. plicata Donn.

T. heterophylla (Raf) Sarg.

Small tree and seedlings

A. amabilis (Dougl) Forbes.

A. sinuata (Regel) Rybd.

P. monticola Dougl.

P. menziesii (Mirbel) Franco.

T. plicata Donn.

T. heterophylla (Raf) Sarg.

Shrubs

G. shallon Pursh.

R. macrophyllum G. Don.

R. gymnocarpa Nutt.

Spirea douglassi Hook. (Douglas' spirea).

V. alaskense Howell.

V. membranaceum Dougl.

Herbs indicative of plant associations present

Caltha biflora D. C. (white marshmarigold).

C. quamash (Pursh) Greene.

Lysichitum americanum Hulten and St. John. (skunk cabbage).

Maianthemum dilatatum (Wood) Nels and Macbr. (wild lily-of-the-valley).

Site 12

1. Location - Hickman Creek. T1S R7E Sect. 36 NW 1/4 WM.
2. Elevation - 2,700 ft.
3. Slope angle - 2% or 1°.
4. Aspect - NNE.
5. Soil type - Stony loam.
6. Plant associations present.
   a. *T. heterophylla/P. munitum/O. oregana.*
   b. *T. heterophylla/P. munitum.*
   c. *T. heterophylla/R. macrophyllum/B. nervosa.*

Canopy

A. amabilis (Dougl) Forbes.

P. menziesii (Mirbel) Franco.

T. plicata Donn.

T. heterophylla (Raf) Sarg.

Small tree and seedling

A. amabilis (Dougl) Forbes.

A. circinatum Pursh.

T. plicata Donn.

T. heterophylla (Raf) Sarg.

Shrubs

M. ferruginea Smith.

O. horridum (Smith) Miq.

R. macrophyllum G. Don.

R. spectabilis Pursh.

V. alaskense Howell.

V. membranaceum Dougl.

V. parvifolium Smith.

Herbs indicative of plant associations present

A. triphylla (Smith) D. C.

A. filix-femina (L) Roth.

B. spicant (L) Roth.

G. oblongifolia Raf.

L. borealis L.

O. oregana Nutt.

V. hexandra (Hook) Morr and Dec.

Site 13

1. Location - Big Bend Mountain. T1S R7E Sect. 21 NW 1/4 WM.

2. Elevation - 3,400 ft.
3. Slope angle - 25% or 14°
4. Aspect - SW.
5. Soil type - Silt loam.
6. Plant associations present.
   a. *A. amabilis/S. roseus.*
   b. *A. amabilis/V. alaskense.*
   c. *A. amabilis/X. tenax.*

Canopy

A. amabilis (Dougl) Forbes.

P. menziesii (Mirbel) Franco.

T. heterophylla (Raf) Sarg.

Small tree and seedlings

A. amabilis (Dougl) Forbes.

A. circinatum Pursh.

Sorbus sitchensis Roemer. (Oregon mountain ash).

T. heterophylla (Raf) Sarg.

Shrubs

B. nervosa Pursh.

M. ferruginea Smith.

V. alaskense Howell.

V. membranaceum Dougl.

V. parvifolium Smith.

Herbs indicative of plant associations present

A. triphylla (Smith) D. C.

C. uniflora (Schult) Kunth.

C. canadensis L.

S. stellata(L) Desf.

X. tenax (Pursh) Nutt.

Site 14

1. Location - Hickman Butte. T2S R7E Sect. 2 SW 1/4 WM.
2. Elevation - 4,000 ft.
3. Slope angle - 10% or 5.7°.
4. Aspect - WSW.
5. Soil type - Angular cobbly loam.
6. Plant associations present.
   a. *A. amabilis/S. roseus.*
   b. *A. amabilis/V. alaskense.*

Canopy

A. amabilis (Dougl) Forbes.

A. procera Rehder.

P. monticola Dougl. (White pine).

P. menziesii (Mirbel) Franco.

T. plicata Donn.

T. heterophylla (Raf) Sarg.

T. mertensiana (Bong) Carr.

Small tree and seedlings

A. procera Rehder.

A. circinatum Pursh.

A. sinuata (Regel) Rybd.

Pinus monticola Dougl.

S. sitchensis Roemer.

T. plicata Donn.

T. heterophylla (Raf) Sarg.

Shrubs

G. shallon Pursh.

M. ferruginea Smith.

R. macrophyllum G. Don.

S. douglassi Hook.

V. alaskense Howell.

V. membranaceum Dougl.

Herbs indicative of plant associations present

A. filix-femina (L) Roth.

B. spicant (L) Roth.

C. uniflora (Schult) Kunth.

C. canadensis L.

Site 15

1. Location - Aschoff Butte. T2S R7E Sect. 6 SE 1/4 WM.
2. Elevation - 3,500 ft.
3. Slope angle - 50% or 26.5°.

4. Aspect - SSW.

5. Soil type - Very gravelly loam.

6. Plant associations present.

   a. *A. amabilis/V. alaskense.*

   b. *A. amabilis/X. tenax.*

   c. *A. amabilis/G. shallon.*

Canopy

A. amabilis (Dougl) Forbes.

P. menziesii (Mirbel) Franco.

T. heterophylla (Raf) Sarg.

Small trees and seedlings

A. amabilis (Dougl) Forbes.

A. circinatum Pursh.

T. heterophylla (Raf) Sarg.

Shrubs

B. nervosa Pursh.

G. shallon Pursh.

M. ferruginea Smith.

R. macrophyllum G. Don.

R. gymnocarpa Nutt.

V. alaskense Howell.

V. membranaceum Dougl.

V. parvifolium Smith.

Herbs indicative of plant associations present

C. uniflora (Schult) Kunth.

C. canadensis L.

L. borealis L.

X. tenax (Pursh) Nutt.

Site 16

1. Location - Cedar Creek. T1S R7E Sect. 32 NW 1/4 WM.
2. Elevation - 2,000 ft.
3. Slope angle - 10% or 5.6°.
4. Aspect - WSW.
5. Soil type - Silt loam.
6. Plant associations present
   a. *T. heterophylla/P. munitum/O. oregana.*
   b. *T. heterophylla/P. munitum.*

Canopy

A. amabilis (Dougl) Forbes.

Alnus rubra Bong. (red alder).

T. plicata Donn.

T. heterophylla (Raf) Sarg.

Small trees and seedlings

A. amabilis (Dougl) Forbes.

A. circinatum Pursh.

A. rubra Bong.

T. plicata Donn.

T. heterophylla (Raf) Sarg.

Shrubs

O. horridum (Smith) Miq.

Rubus parviflorus Nutt. (thimbleberry).

R. spectabilis Pursh.

S. racemosa L.

V. membranaceum Dougl.

V. parvifolium Smith.

Herbs indicative of plant associations present

A. filix-femina (L) Roth.

B. spicant (L) Roth.

O. oregana Nutt.

L. borealis L.

T. trifoliata L. var. *unifoliata* (Hook) Kuntz.

APPENDIX C

SMALL MAMMAL TRAP DATA PER PLANT ASSOCIATION

TRAP DATA/PLANT ASSOCIATION IN THE *Abies amabilis* ZONE

Mammal Species / Plant Association	*A. amabilis/ O. horridum*		*A. amabilis/ S. roseus*		*A. amabilis/ V. alaskense*		*A. amabilis/ X. tenax* (Dry lithosol)		*A. amabilis/ G. shallon*				DRY MEADOW: *S. divergens/ Solidago* sp.		TALUS COMMUNITY: *A. circinatum/ C. crispa/ A. trichomanes*	
	No. of individuals trapped	No. of sites trapped			No. of individuals trapped	No. of sites trapped										
Sorex vagrans	5	2	13	4	14	5	3	2	1	1			-	-	-	-
Sorex trowbridgii	4	2	7	3	10	4	6	3	5	3			-	-	2	1
Neurotrichus gibbsii	-	-	-	-	-	-	-	-	-	-			-	-	-	-
Ochotona princeps	-	-	-	-	1	1	1	1	1	1			-	-	-	-
Eutamias townsendii	4	3	5	4	6	5	1	1	9	2			-	-	8	1
Thomomys monticola	-	-	-	-	-	-	-	-	-	-			3	1	-	-
Peromyscus maniculatus	6	2	6	2	7	3	1	1	4	2			7	1	3	1
Neotoma cinerea	-	-	-	-	-	-	-	-	-	-			-	-	-	-
Cleth. occidentalis	2	2	9	3	12	5	10	3	3	2			-	-	1	1
Microtus longicaudus	-	-	-	-	-	-	-	-	-	-			-	-	-	-
Microtus oregoni	-	-	5	1	5	1	-	-	-	-			1	1	-	-
Arvicola richardsoni	-	-	-	-	-	-	-	-	-	-			-	-	-	-
Zapus trinotatus	11	2	11	2	11	2	-	-	3	1			3	1	3	1

TRAP DATA/PLANT ASSOCIATION IN THE *Tsuga heterophylla* ZONE

Mammal Species / Plant Association	*T. heterophylla/ P. munitum/ O. oregano*		*T. heterophylla/ P. munitum*		*T. heterophylla/ R. macrophyllum/ B. nervosa*		*T. heterophylla/ R. macrophyllum/ G. shallon*		*T. heterophylla/ C. chrysophylla*		*P. menziesii/ H. discolor*		TALUS COMMUNITY: *A. circinatum/ C. crispa/ A. trichomanes*		WET MEADOW: *C. biflora/ C. quamash/ S. douglassi*	
	No. of individuals trapped	No. of sites trapped	—	—	No. of individuals trapped	No. of sites trapped	—	—	—	—	—	—	—	—	—	—
Sorex vagrans	4	3	4	3	-	-	-	-	-	-	-	-	-	-	1	1
Sorex trowbridgii	12	3	20	4	8	1	-	-	-	-	7	1	7	1	-	-
Neurotrichus gibbsii	2	1	2	1	-	-	-	-	-	-	-	-	-	-	-	-
Ochotona princeps	-	-	-	-	-	-	-	-	-	-	2	1	2	1	-	-
Eutamias townsendii	4	2	4	2	3	1	-	-	-	-	2	1	2	1	-	-
Thomomys monticola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Peromyscus maniculatus	7	4	7	4	1	1	-	-	-	-	5	1	5	1	-	-
Neotoma cinerea	5	2	5	2	-	-	-	-	-	-	-	-	-	-	-	-
Cleth. occidentalis	2	1	3	2	3	2	-	-	-	-	-	-	-	-	-	-
Microtus longicaudus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Microtus oregoni	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arvicola richardsoni	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	1
Zapus trinotatus	19	3	19	3	10	1	-	-	-	-	-	-	-	-	1	1

APPENDIX D

SPECIES COMPOSITION AND ABUNDANCE PER PLANT ASSOCIATION

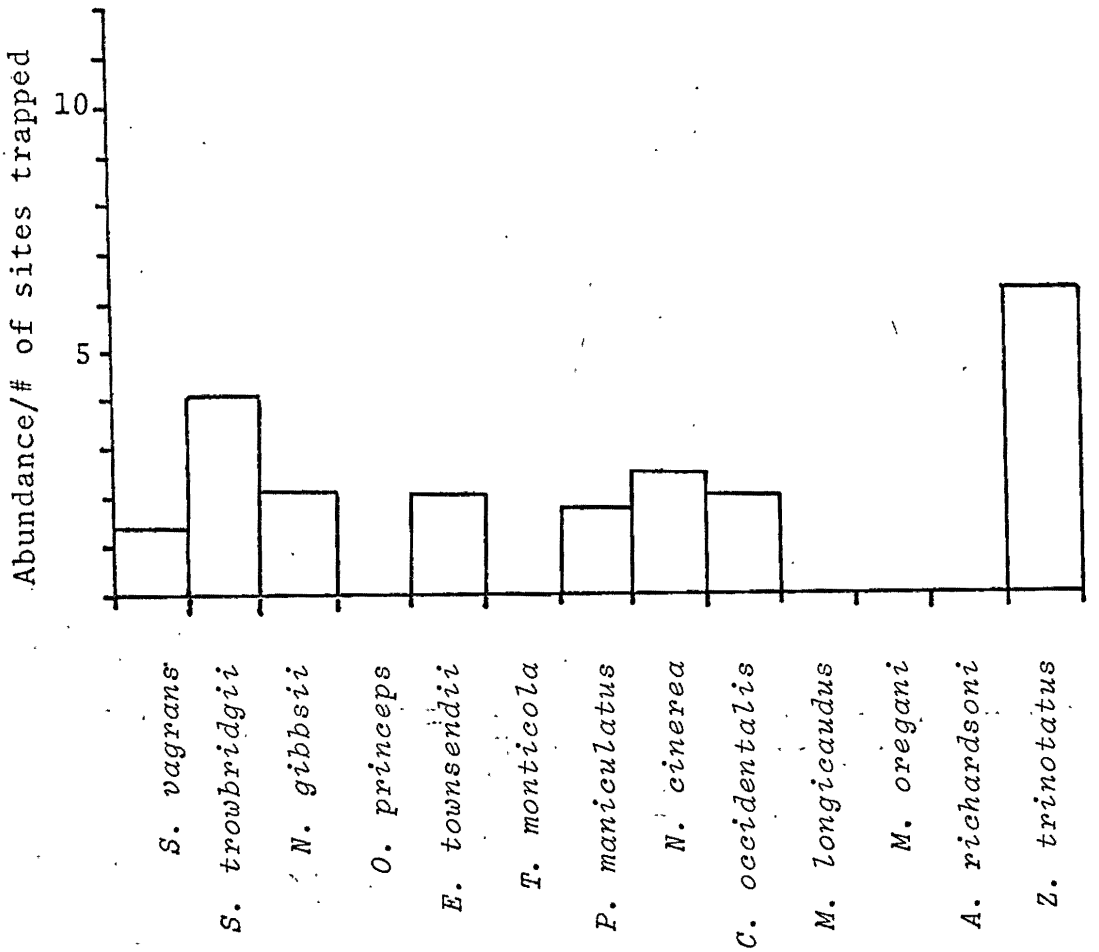

Figure 23. Species composition and abundance in the *T. heterophylla/P. munitum/O. oregana* plant association.

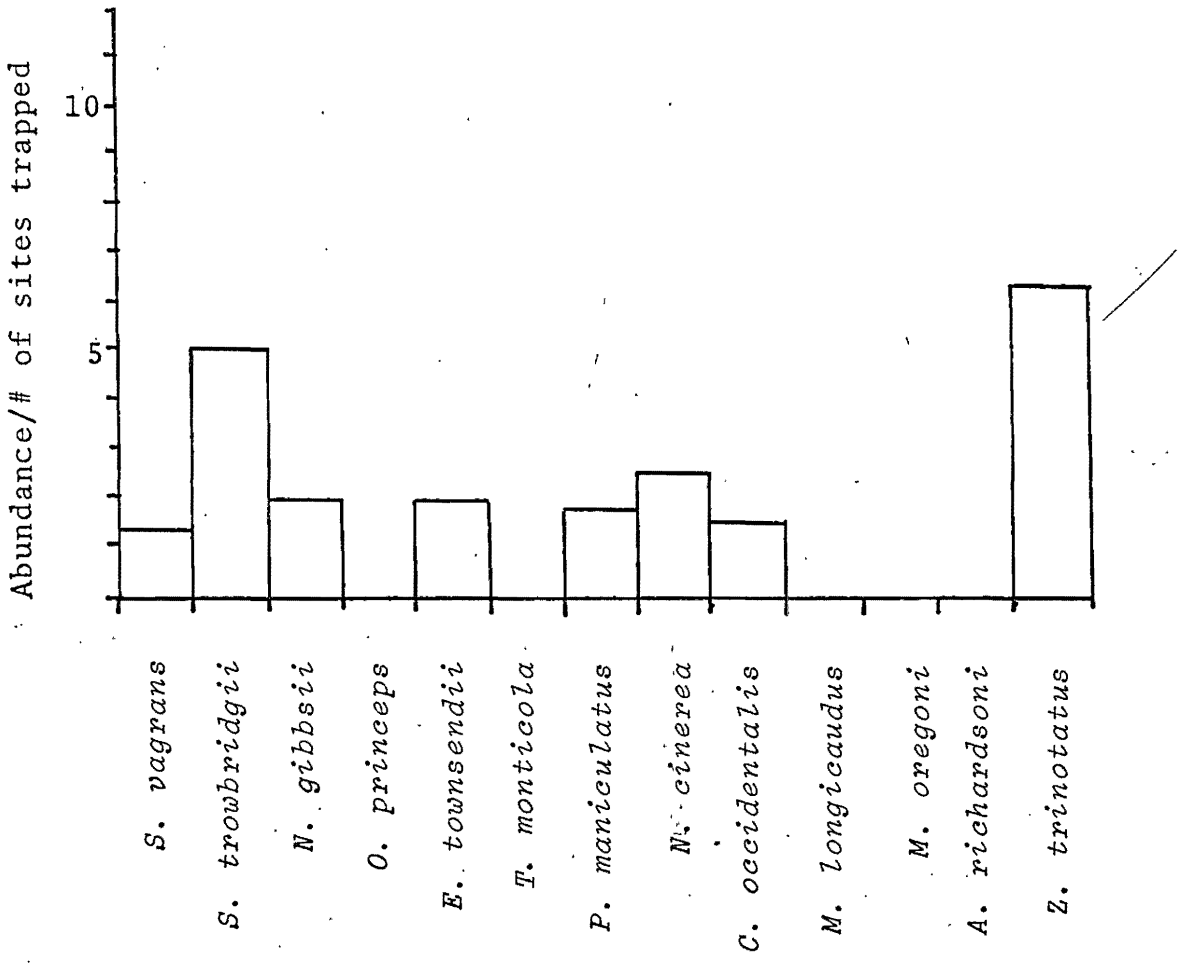

Figure 24. Species composition and abundance in the *T. heterophylla/P. munitum* plant association.

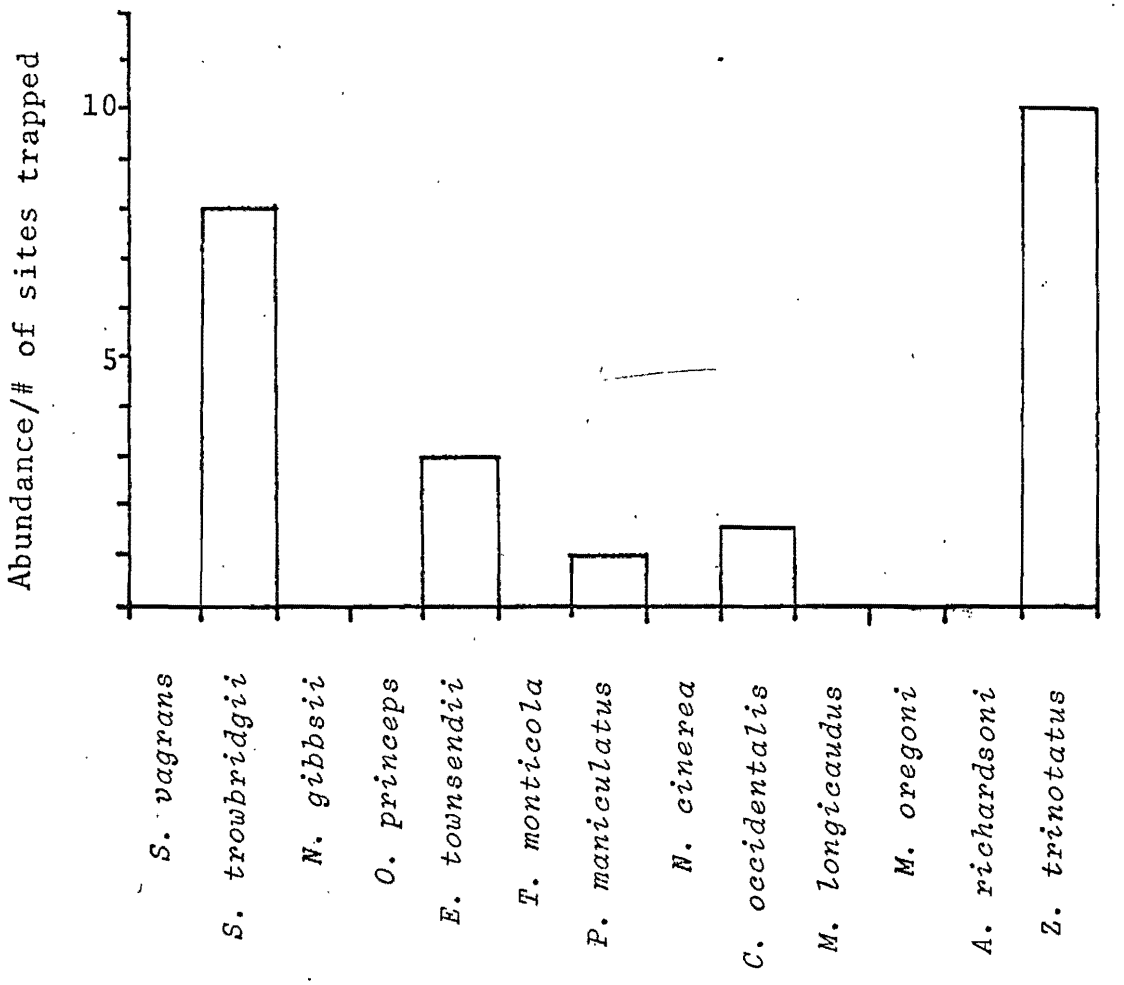

Figure 25. Species composition and abundance in the *T. heterophylla/R. macrophyllum/B. nervosa* plant association.

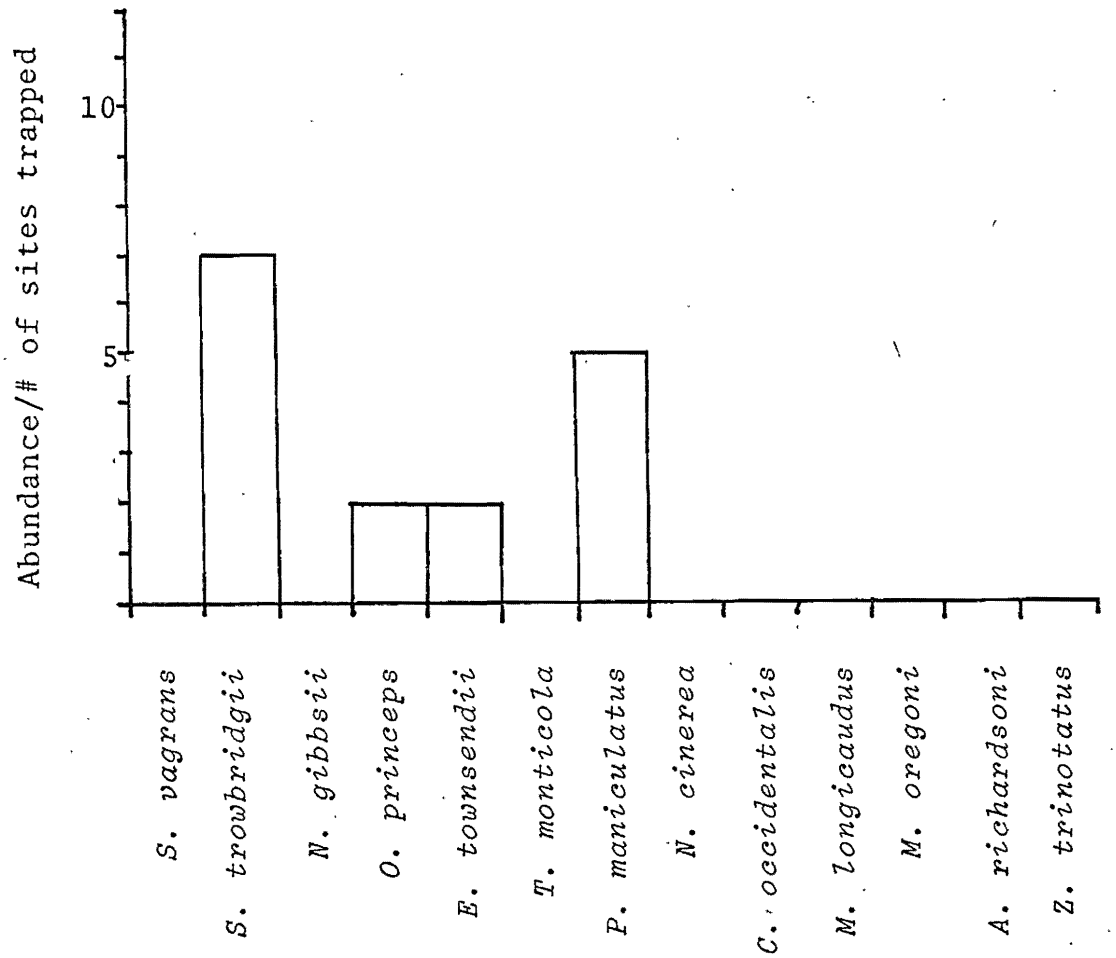

Figure 26. Species composition and abundance in the *P. menziesii/H. discolor* plant association.

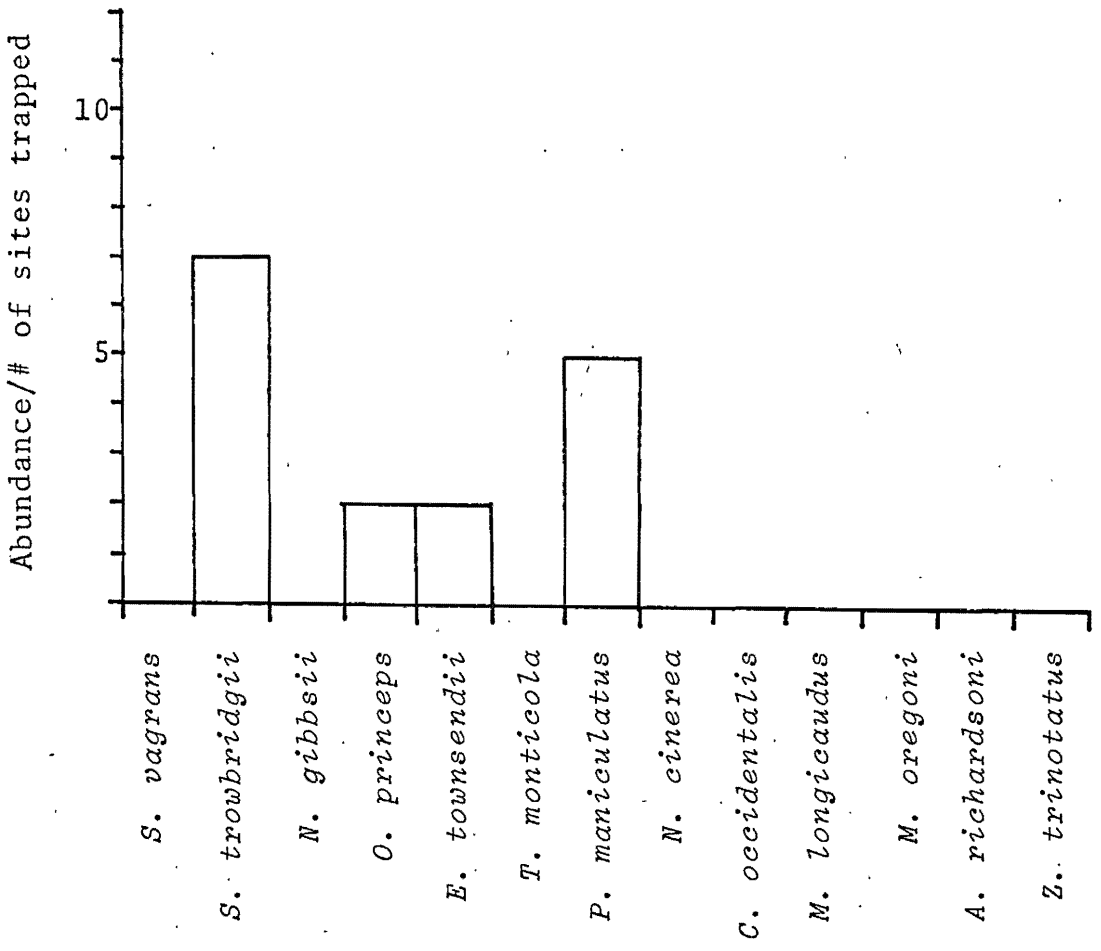

Figure 27. Species composition and abundance in the *T. heterophylla* talus community.

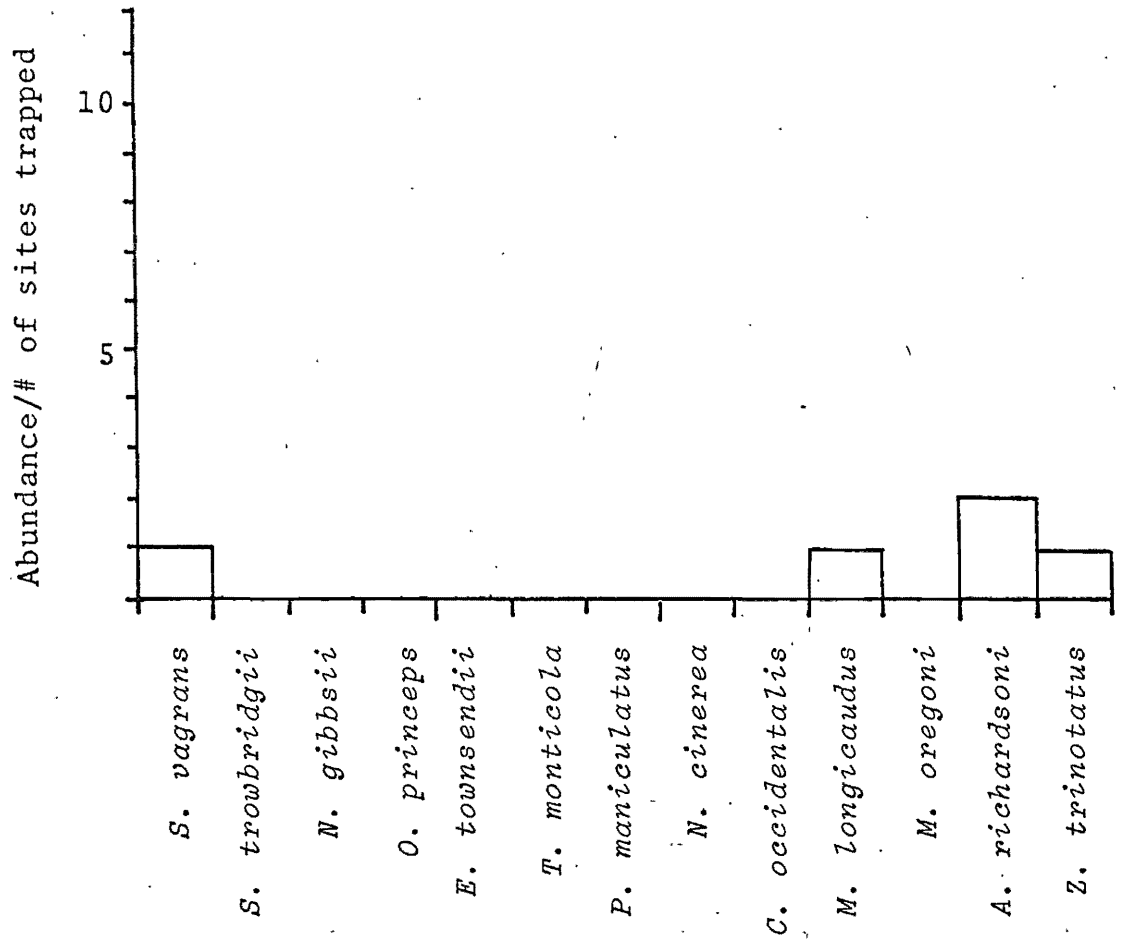

Figure 28. Species composition and abundance in the *T. heterophylla* wet meadow community.

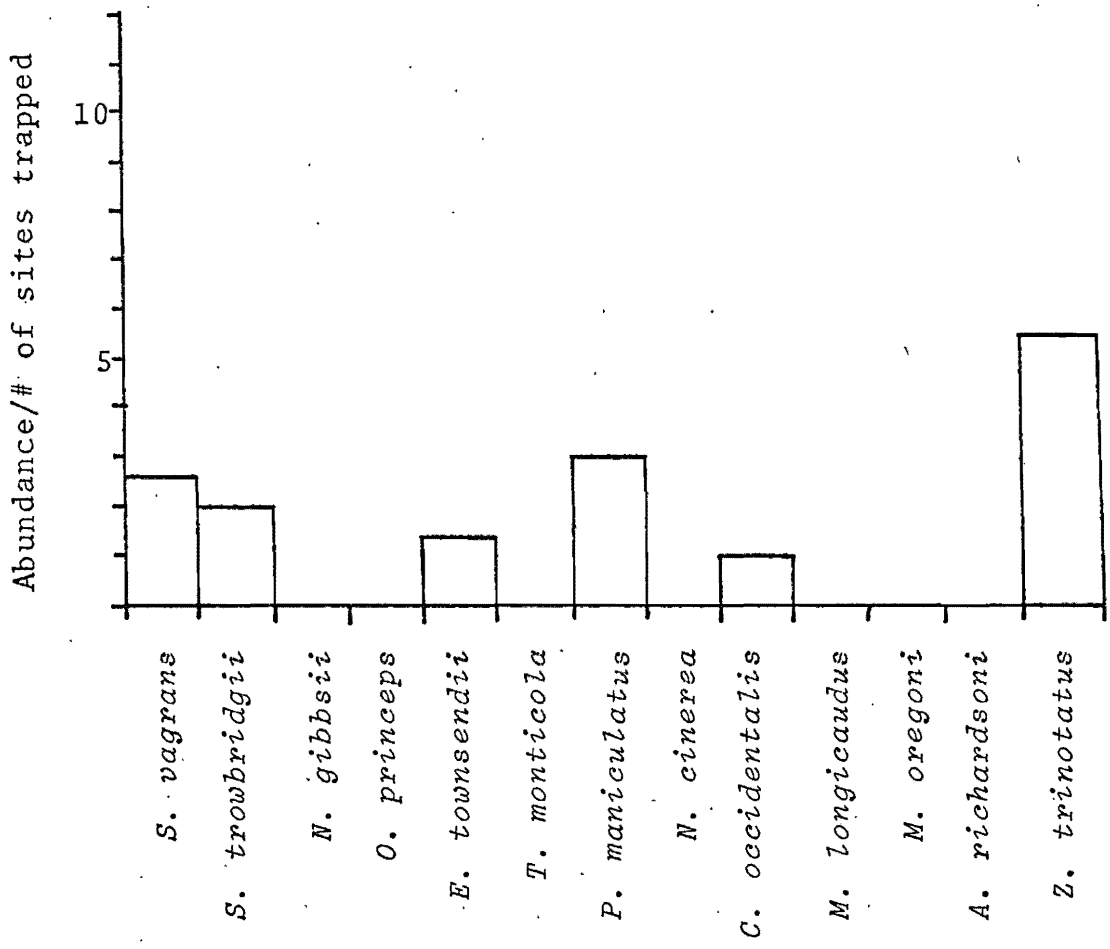

Figure 29. Species composition and abundance in the *A. amabilis/O. horridum* plant association.

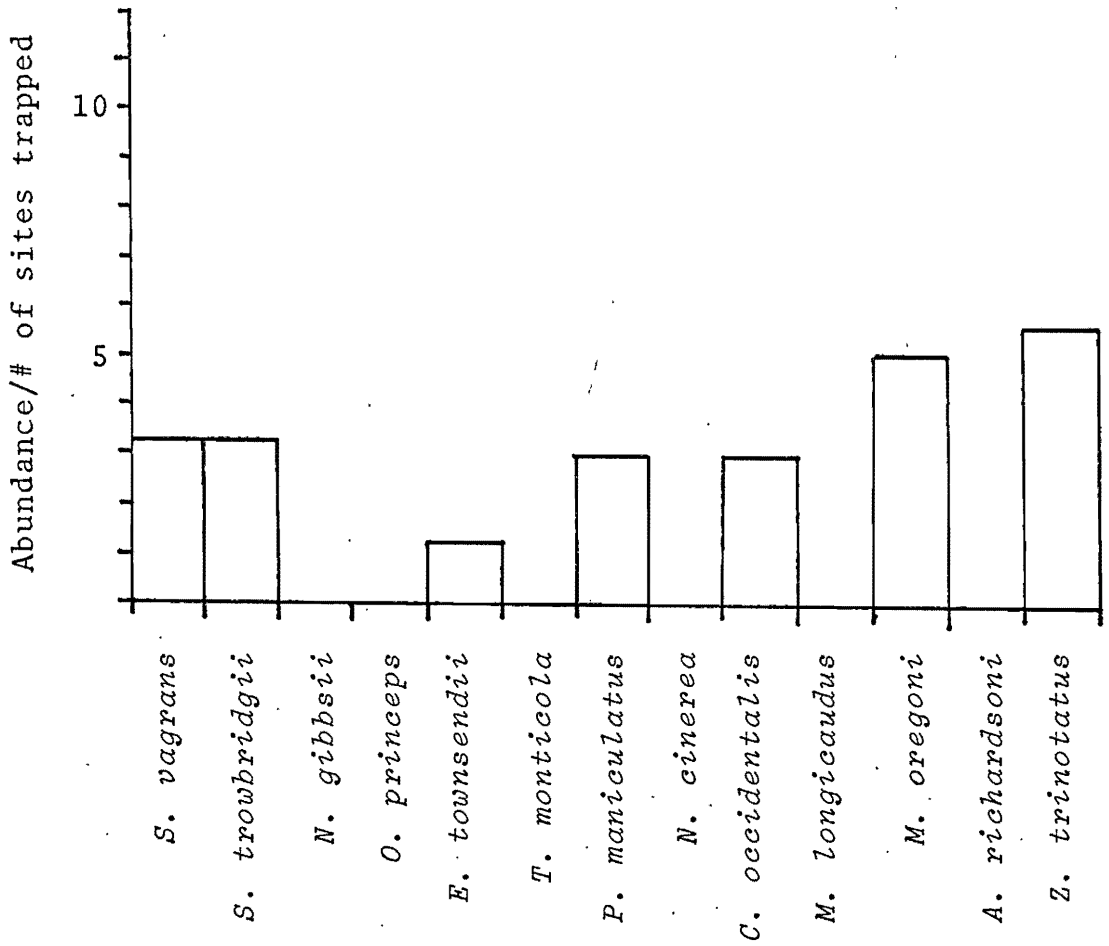

Figure 30. Species composition and abundance in the *A. amabilis/S. roseus* plant association.

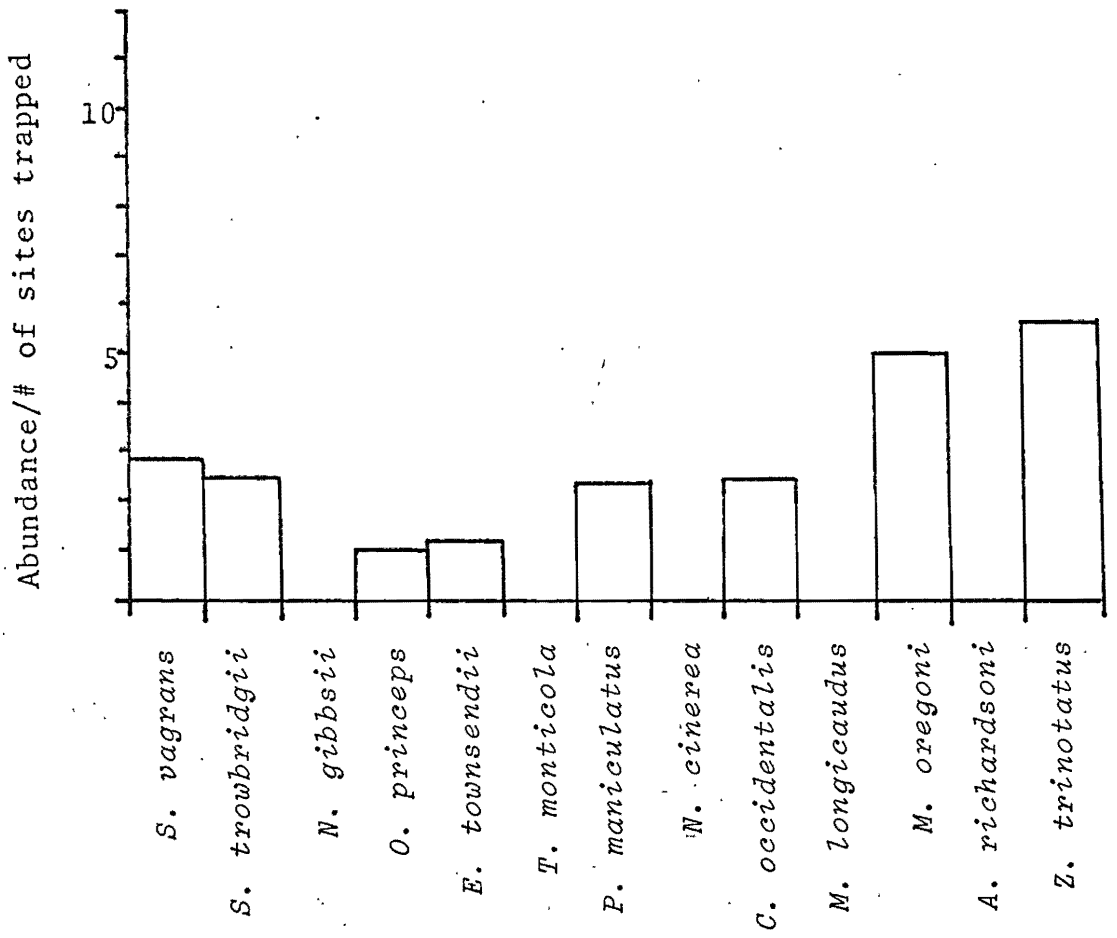

Figure 31. Species composition and abundance in the *A. amabilis/V. alaskense* plant association.

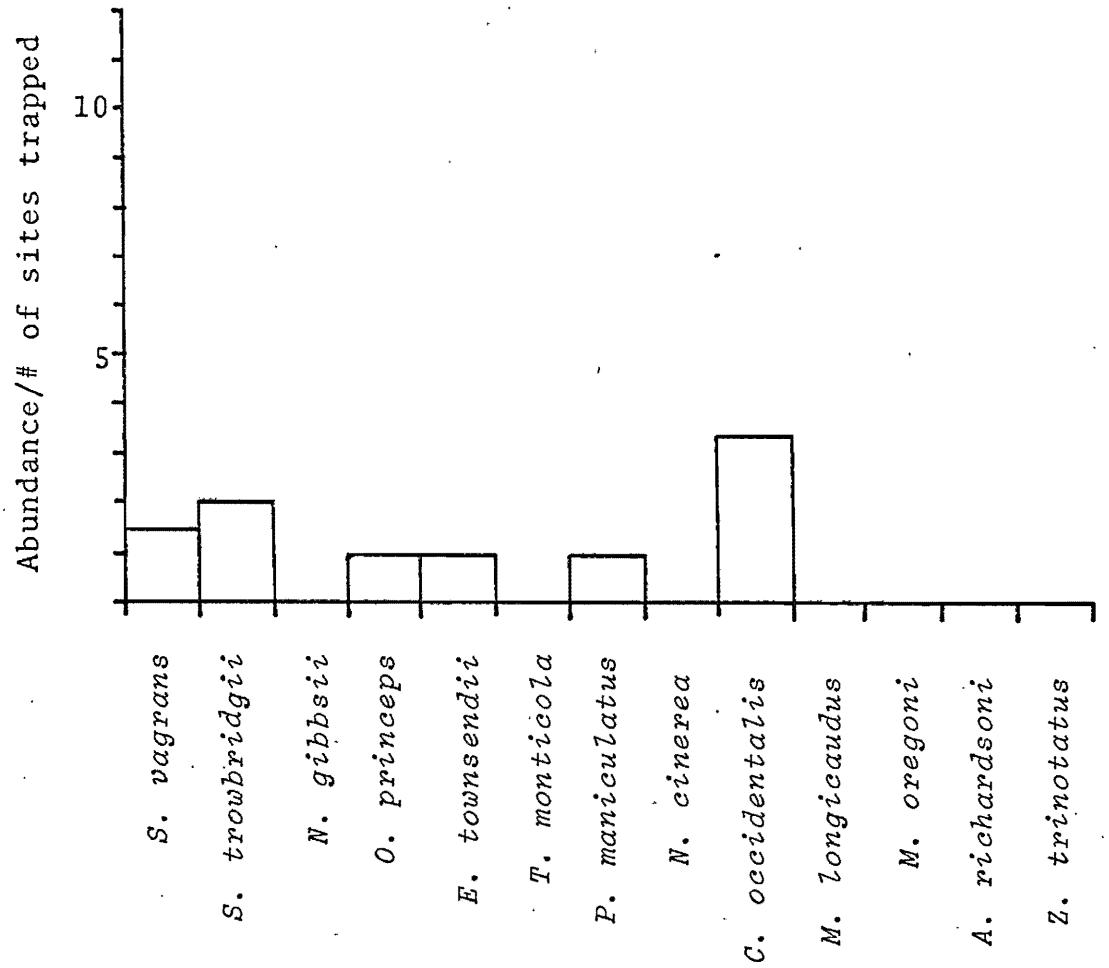

Figure 32. Species composition and abundance in the *A. amabilis/X. tenax* (dry-lithosol) plant association.

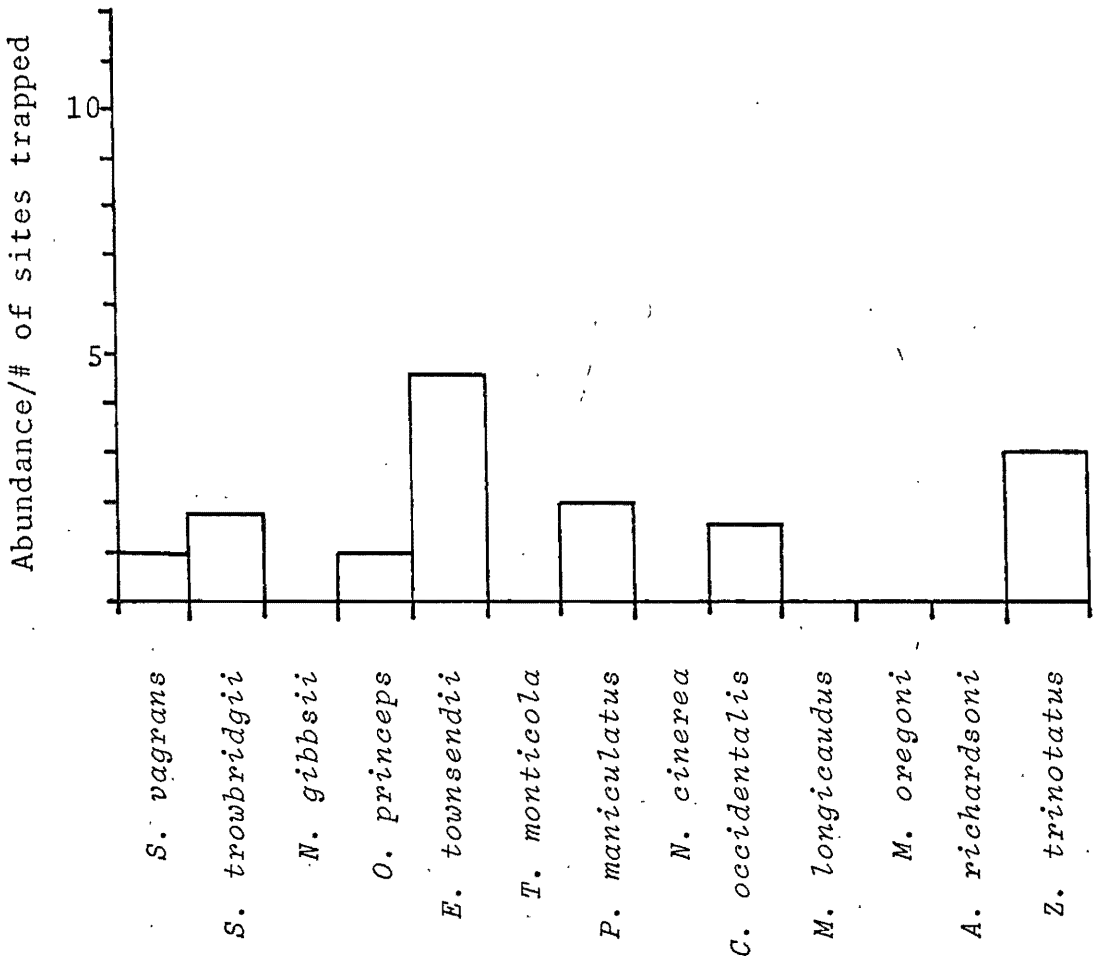

Figure 33. Species composition and abundance in the *A. amabilis/G. shallon* plant association.

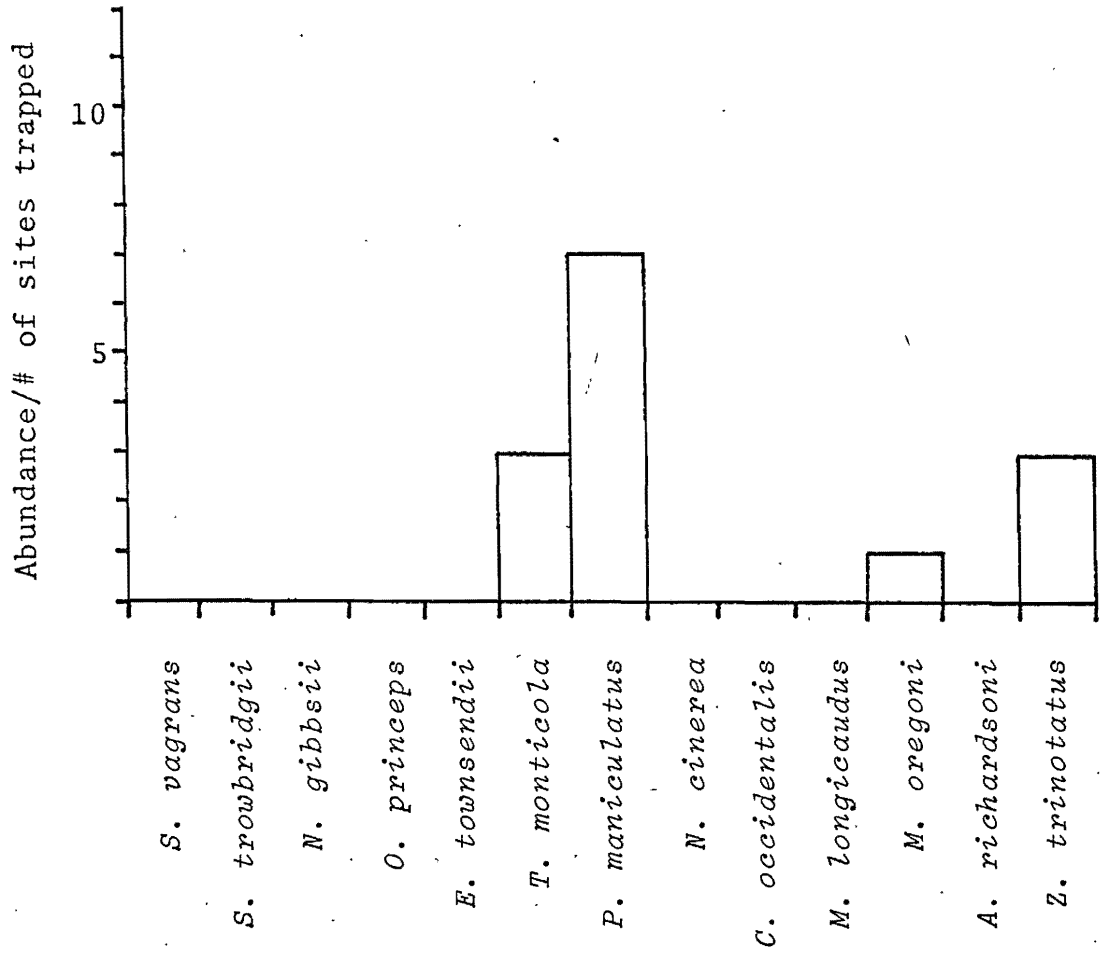

Figure 34. Species composition and abundance in the *A. amabilis* dry meadow community.

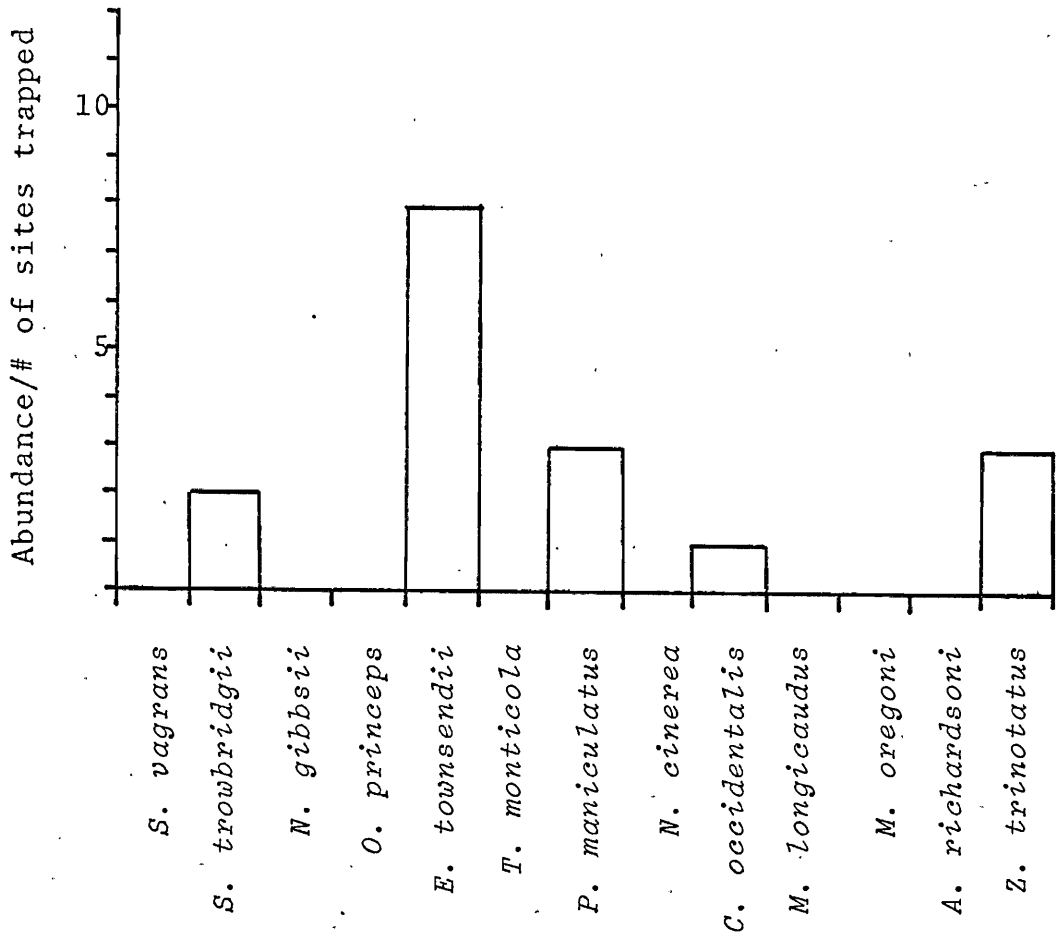

Figure 35. Species composition and abundance in the *A. amabilis* talus community.